Appendix D. Final Supplement Coordination Act Report

Supplemental Fish and Wildlife Coordination Act Report,
Savage Rapids Dam,
Grants Pass Division, Rogue River, Oregon

Prepared for the
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PREFACE

This is the Fish and Wildlife Service's (Service) detailed report on the proposed Savage Rapids Dam Removal, Josephine County Water Management Improvement Study, Jackson and Josephine Counties, Oregon. A planning aid letter was submitted on this proposed project in April 1990. A 1995 Coordination Act Report (1995 report) provided the Service's position regarding the proposed project (Garst 1995). Our original analysis of project impacts in the 1995 report regarding fish and wildlife resources was based on project information and engineering data provided by the U.S. Bureau of Reclamation (Reclamation) through December 1994.

Information in this detailed report includes additional information provided by Reclamation through May 2005 regarding the current preferred action alternative (dam removal). This report provides information from the Oregon Department of Fish and Wildlife (ODFW), National Marine Fisheries Service (NMFS) (collectively, with the Service, the resource agencies) regarding fish and wildlife resources. This report supercedes the Service's 1995 report regarding the proposed project. This detailed report supplies information to assist Reclamation in implementing the current preferred action alternative (dam removal) by including: 1) discussion and specific recommendations regarding the current preferred action alternative, 2) discussion, rationale and specific recommendations regarding the actions to protect fish and wildlife resources during inwater work activities; and, 3) discussion, rationale and specific recommendations regarding timing of inwater work activities to protect fish and wildlife resources.

Because the alternative to construct a pumping facility and remove Savage Rapids Dam has been chosen, this report does not update the original discussion of the costs and resources benefits associated with the dam retention and dam removal alternatives originally presented in the 1995 report. Where appropriate, we have updated information describing the number of fish passing Savage Rapids and Gold Ray dams, the listing status of salmon and steelhead stocks in the Rogue River, and actions affecting fish and wildlife resources that have been taken between 1995 and May 2005. The resource agencies still consider the original discussion and recommendations contained in the 1995 report, which address the dam retention and dam removal alternatives, to be appropriate.

It should be noted that the proposed project may be subject to permits over which the Service has review responsibilities. Accordingly, our report does not preclude an additional and separate evaluation by the Service, pursuant to the Fish and Wildlife Coordination Act (16 U.S.C. 661, *et seq*.), if eventual project development requires a permit. All such permits are subject to separate review by the Service under existing statues, executive order, memorandum of agreement and other authorities. In review of permit application, the Service may concur, with or without stipulations, or object to the proposed work, depending on specific construction practices, which may impact fish and wildlife resources.

Additionally, this detailed report does not preclude the need for Section 7 consultation, pursuant to the Endangered Species Act of 1973(Act), as amended (16 U.S. C. 1531 *et seq*.), regarding impacts to listed species resulting from the proposed project.

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INTRODUCTION

This report contains an evaluation of the impacts of removal of Savage Rapids Dam (SRD) on fish and wildlife resources. It was prepared in cooperation with the Oregon Department of Fish and Wildlife (ODFW), National Marine Fisheries Service (NMFS), Northwest Region of the Bureau of Reclamation (Reclamation), and Grants Pass Irrigation District (GPID). Letters of concurrence from ODFW and NMFS are attached to the executive summary. Contents are based partially on information contained in other reports: 1) Draft Planning Report and Environmental Impact Statement (USBR 1994); 2) Final Water Management Study Report (GPID 1994) ; 3) Fish Passage Improvements Progress Report (USBR 1992); 4) Savage Rapids Dam, Grants Pass division, Planning Aid Memorandum from the Service to Reclamation (FWS 1990); 5) earlier evaluation of fish losses and benefits associated with SRD and dam removal (FWS 1981 and NMFS 1979); 6) analysis of SRD impacts on Rogue River anadromous fish (ODFW 1994 and 1995); 7) the Service's 1995 Coordination Act Report; and 8) the 2001 Savage Rapids Dam Sediment Evaluation Study (USBR 2001).

The GPID was formed in 1917 to irrigate a potential area of about 18, 400 acres and the original permit for water use was issued for 230 cubic feet per second (cfs); however, the historic diversion rate has ranged between 180 and 190 cfs and the maximum area irrigated has been about 12,000 acres. A final proof survey completed by the Oregon Water Resources Department (OWRD) identified 7,755 irrigated acres and a water right of 96.94 cfs was issued in 1982. Subsequently, GPID applied for a permit to use additional water because of its subject of a dispute between OWRD, GPID and other parties. A negotiated agreement followed which allowed GPID to: 1) divert the average historical diversion for a period of time, during which GPID was to identify needed measures, where possible, as part of their management plans; 2) justify a need for any water greater than 96.94 cfs; and 3) identify solutions to the fish passage problems at SRD. These findings are presented in the GPID Water Management Study final report to the Oregon Water Resources Commission dated March 8, 1994. On October 28, 1994, The Oregon Water Resources Commission completed its review of the GPID plans and accepted them, granting an extension of a temporary permit until October 15, 1999. This permit allows for continued full service to GPID lands and the requirement to implement the preferred plan for fish passage (dam removal) within the permit time period.

Issues examined by GPID include water use and water needs, alternative water supplies, water conservation measures, existing and future land use and how it would affect water use, other beneficial uses (besides irrigation) supported the present system, and fish losses caused by SRD and the water conveyance system The findings of the study were developed by all oversight committee consisting of Reclamation, ODFW, Service, OWRD, GPID and its consultant, David Newton Associates, Natural Resources Conservation Service (NRCS) , WaterWatch of Oregon, City of Grants Pass, Josephine county, and other local interests. The issue of anadromous fish passage problems at SRD is considered to be a Federal interest because anadromous fish are:

- Species of high national interest,
- The subject of international treaties,

- Some stocks have been petitioned, proposed for listing, and subsequently listed under the Endangered Species Act; and,
- The Federal Government has a history of involvement at SRD through contractual agreement between the GPID and Reclamation.

In 1971 congress authorized Reclamation to conduct a feasibility study of the Grants Pass Division, Rogue River Basin Project, including fish passage issues at SRD. A special report by the Service and Reclamation in 1974, and subsequent Final Environmental Impact Statement, resulted in Congressional authorization to implement the interim measures in that report. Ongoing detailed studies indicated economic benefits for either dam removal or rehabilitation of the existing facilities, and controversies developed between these two choices. Solicitations for bids to replace the north fish ladder received only one response (which exceeded available funds) and, in 1979, a decision was made to expend remaining funds on interim improvements until agreement and sufficient funds were available for a permanent solution. The preferred Federal action was to build pumping facilities, then remove SRD. The pumping facilities would provide water to GPID, and, at the same time, finally resolve long-term fish passage problems existing at the dam. This action supported the decision of the Board of Directors of GPID as identified in the final Water Management Study Report, the permit extension as granted by the commission, and is the economical and biological solution to the existing fish passage problems.

A planning report/final environmental statement (PR/FES), filed by Reclamation on August 30, 1995, and subsequent record of decision (ROD), signed on March 14, 1997, focused on salmon and steelhead passage concerns at the dam and the associated diversion facilities while providing continued irrigation water supply for the GPID. The FES concluded that fish passage and protective facilities at SRD were inadequate and caused a significant loss of salmon and steelhead. The FES also included a preferred alternative (Pumping Alternative) that included removal of the existing dam. This alternative provided the greatest net economic benefits consistent with protecting the Rogue River fisheries. Also, it would result in the re-establishment of a free-flowing reach of river while providing new electrically driven irrigation diversion pumping facilities.

With the completion of the PR/FES and ROD, Reclamation considered its study of alternatives to improve salmon and steelhead passage at SRD and the evaluation of those alternatives under the National Environmental Policy Act to be complete. Reclamation chose not to pursue authorization and funding to implement the PR/FES Preferred Alternative because of a lack of strong local consensus.

After completion of the PR/FES, the Oregon Legislature passed a law directing establishment of a task force to review the findings of the report and to make recommendations. That task force completed its work and recommended a dam retention option. The task force based its recommendation largely on sediment-related concerns which resulted from documented examples of sediment damage to other North American rivers where dams were either demolished or breached by high water. Concerns regarding the accumulated sediment behind Savage Rapids Dam continued to be expressed by the chairman of the task force following release of the task force recommendations. The following sediment-related issues were discussed by the task force:

- The sediment may contain hazardous contaminants from upstream mining and other human activities.
- The sediment might plug pumps or cause elevated maintenance costs for pumps proposed for construction immediately downstream from the dam to supply water to the GPID.
- Release of the sediment could affect fisheries and fish habitat downstream from the dam.
- Release of sediment could affect the municipal water supply system of the City of Grants Pass, which is located five miles downstream from the dam.
- Release of the sediment could cause barriers to safe navigation of the Rogue River downstream from the dam.

Sportfish Heritage funded sampling and testing of the sediment behind the dam in 1998, and McLaren/Hart conducted the sampling under contract. McLaren/Hart checked for the presence of toxic metals and volatile organic compounds (VOCs). The Environmental Protection Agency reviewed the McLaren/Hart (Sportfish Heritage) report and concluded the data contained therein indicated that release of the sediments would present minimal ecological risk from VOCs or heavy metals contamination.

Reclamation originally planned to do a detailed sediment study as part of pre-design activities if the Congress approved the removal of the dam and provided adequate funding to do so. However, GPID, the Oregon Water Resources Department, NMFS, WaterWatch, and others agreed that the sediment study should occur sooner (to accomplish that goal). These entities assisted in acquiring Federal funding for this sediment evaluation study.

The results of the 2001 Savage Rapids Dam Sediment Evaluation Study were as follows:

- *Reservoir Sediment Volume Estimate* – 200,000 cubic yards.
- *Reservoir Sediment Sizes and Distribution* – two percent fines (silt and clay-sized particles), 71 percent sand, and 27 percent gravel overall. Twenty percent of the deposits are composed of cobbles from 3 to 5 inches in diameter. A finer-grained bar deposit is present on the south side of the reservoir but is less than 10 percent of total sediment volume.
- *Chemical Composition of Reservoir Sediment* – Testing of reservoir sediment indicated no contaminants with concentrations significantly higher than naturally occurring background levels. The chemical composition of reservoir sediment would not pose any hazard to water quality, fish and wildlife, or human uses if released downstream.
- *Rate and Extent of Reservoir Sediment Erosion* – Model results show that virtually all sediment would be eroded from the reservoir following the removal of Savage Rapids Dam. About three-fourths of the sediment would be eroded from the area immediately upstream from Savage Rapids Dam within the first year.
- *Rate of Sediment Transport Downstream* – Reservoir sediment would be transported past the Applegate River confluence within a 1- to 10-year period. The specific length of time would depend on the frequency and magnitude of highflow events following

dam removal. High and frequent floods following dam removal would cause reservoir sediment to reach the ocean within a few years.

- *Sediment Deposition Downstream* – Sediment eroded and flushed from the reservoir would be transported downstream. Sediment deposition in pools and eddies would occur during low-flow periods as it does now. Maximum deposition will range from 1 to 8 feet in river pools. However, no flooding is expected to occur because pool deposition would not cause an increase in water surface elevation. In addition, sediment deposited in pools would subsequently be scoured out and transported downstream during high-flow periods.
- *GPID Pumping Facility* – The new pumping facility could be affected by the initial flushing of reservoir sediments. However, this could be minimized by properly timing dam removal to allow flushing of reservoir sediments during the high flow winter season when GPID will not be diverting water and the sediment is most likely to be transported downstream. To avoid sediment impacts following dam removal, the intake structure could be placed in the channel in a location with a low potential for sediment buildup.
- *City Water Treatment Plant Intake Structures* –High rates of sand deposition in the treatment facility could cause rapid wear on the river intake pumps and complicate the method of removing sand from the plant's sedimentation basins. This deposition of sand could be lessened by releasing sediments during the winter months when flows are higher and the treatment facility is operated at a slower pumping rate and for fewer hours per day. In addition, excessive deposition of coarse sediments in front of the treatment facility could plug the intake structure.

Because the study indicates that upon removal of SRD there would be less sediment released than originally anticipated, all downstream effects would be less than indicated in the *Planning Report/Final Environmental Statement, Fish Passage Improvements, Savage Rapids Dam, Josephine Water Management Improvement Study*, completed in 1995.

The GPID contracted to conduct additional fish passage evaluations from 1998 through 2000 (Table 1). These evaluations looked at the effectiveness of existing juvenile passage facitities, rates of injury and mortality of juvenile salmonids, primarily during the irrigation season (Pellissier and Cramer 2001a, Pellissier and Cramer 2001b); and, effectiveness of adult fish passage facilities (Pellissier and Kalin 2001).

DESCRIPTION OF THE AREA

SRD is located on the Rogue River at River Mile (RM) 107 about 5 miles east of the city of Grants Pass, Oregon (Figure 1 and 2). The Rogue River heads in the Cascade Range near Crater Lake and flows over 215 miles to its confluence with the Pacific Ocean at Gold Beach, Oregon. Elevations range from sea level to over 9,300 feet at the highest point (Mount McLouglin) in the drainage. The total basin area encompasses over 5,000 square miles. Two major tributaries, the Illinois and the Applegate rivers, head in the Siskiyou Mountains and flow north, entering the Rogue at RM 27 and 95, respectively.

Table 1: A Brief History of Fish Passage studies and Construction at Savage Rapids Dam, Rogue River, Oregon

YEAR	ITEM
1921	Savage Rapids Dam constructed with only a northside fish ladder.
1934	South fishway built by the Oregon State Game Commission.
1954	USBR installed steel stoplogs and two river gates to replace the deteriorated bascule gates.
1958	Vertical traveling water screens installed on the two, previously unscreened, hydraulic turbines.
1964-1968	Reports of ODFW and USFWS on continuing problems with fish screens
1971	Feasibility Study for Grants Pass Division authorized (P.L. 92-199) to examine: 1. Interim fish passage problems at Savage Rapids Dam (phase I). 2. Potential for rehabilitating GPID distribution system, and permanent solution to fish passage problems (Phase II).
1974	Congress authorized (P.L. 93-493) construction of interim fish passage improvements based on joint USFWS/USBR report (March, 1974).
1976	Final Environmental Statement filed on anadromous fish passage improvements at SRD. These were interim measures pending a final fish passage program. Some measures outlined in the EIS included: 1. New bulkhead gates in front of the fish screens to facilitate maintenance, 2. Modify south fishway, 3. Replace north fishway, and 4. Other miscellaneous measures.
1977-81	Installation of interim fish passage improvements (rehabilitation and addition of south fishway, renovation of north fishway, bulkhead gates and fish screens).
1979	Formulation Working Document summarizing Phase II study results. Basic conclusions following public review included: 1. Prospects poor for a federal project to improve irrigation facilities, so discontinue study; 2. Upstream and downstream fish passage still a major problem, so further measures should be taken; continue this part of study.
1984	Fisheries study deferred because of uncertainty regarding hydropower development on the Rogue River.
1986	Minor modifications to portions of south ladder accomplished by local fishery groups with ODFW overview.
1999	Monitoring of adult fish passage with video.
2000	Monitoring of Juvenile Fish Passage.
2001	Assessment of injury to juvenile salmonids during passage through the North-Side Bypass.

The climate of the Rogue River basin is dominated by maritime influence which contributes to relatively mild, wet winters and warm, dry summers. Normally about 50 percent of the annual precipitation occurs from November through January, and less than 2 percent falls during July and August. Grants Pass receives about 31.5 inches of precipitation annually, with 90 percent occurring from October through April. Snow accumulates at higher elevations during winter and early spring and becomes the principle source of run-off during late spring through summer. During winter months, only 10 to 20 percent of the flow at the Rogue River mouth originates from Lost Creek Dam (RM 157) but, in July and August, 70 to 75 percent of the total flow is from releases at the dam (ODFW 1985).

The Rogue River basin is surrounded by the Siskiyou Mountains to the south, Cascade Range to the east and north (Umpqua Divide) and the Coast Range to the west. At its upper and lower end, the basin is a relatively narrow valley surrounded by heavily-forested lands managed intensively for timber resources. The basin's interior valley is broader and used mostly for agricultural purposes, supporting the area's population centers and economic development. Medford, Oregon, the largest city in the region, is located about 30 miles southeast of Grants Pass. Most of the useable land within the valley is well developed and fully utilized within limits imposed by soils, climate, topography, water, and-land use categories. Urban growth has significantly encroached on commercial agricultural land and continues to do so in the GPID service area. The city of Grants Pass is located in the central and western portion of the service area and the urban growth boundary for the city encompasses about 60 percent of the service area. Figure 3 shows the configuration of the GPID service area and distribution system of major canals and laterals relative to the location of SRD and the Rogue River. At the downstream end of the project area, the 27-mile Hellgate Recreation Area, a segment of the National Wild and Scenic Rogue River, begins at the confluence of the Applegate River and continues to Grave Creek. This river reach provides a broad range of land-and-water based recreation opportunities managed by the Bureau of Land Management (BLM) Medford District.

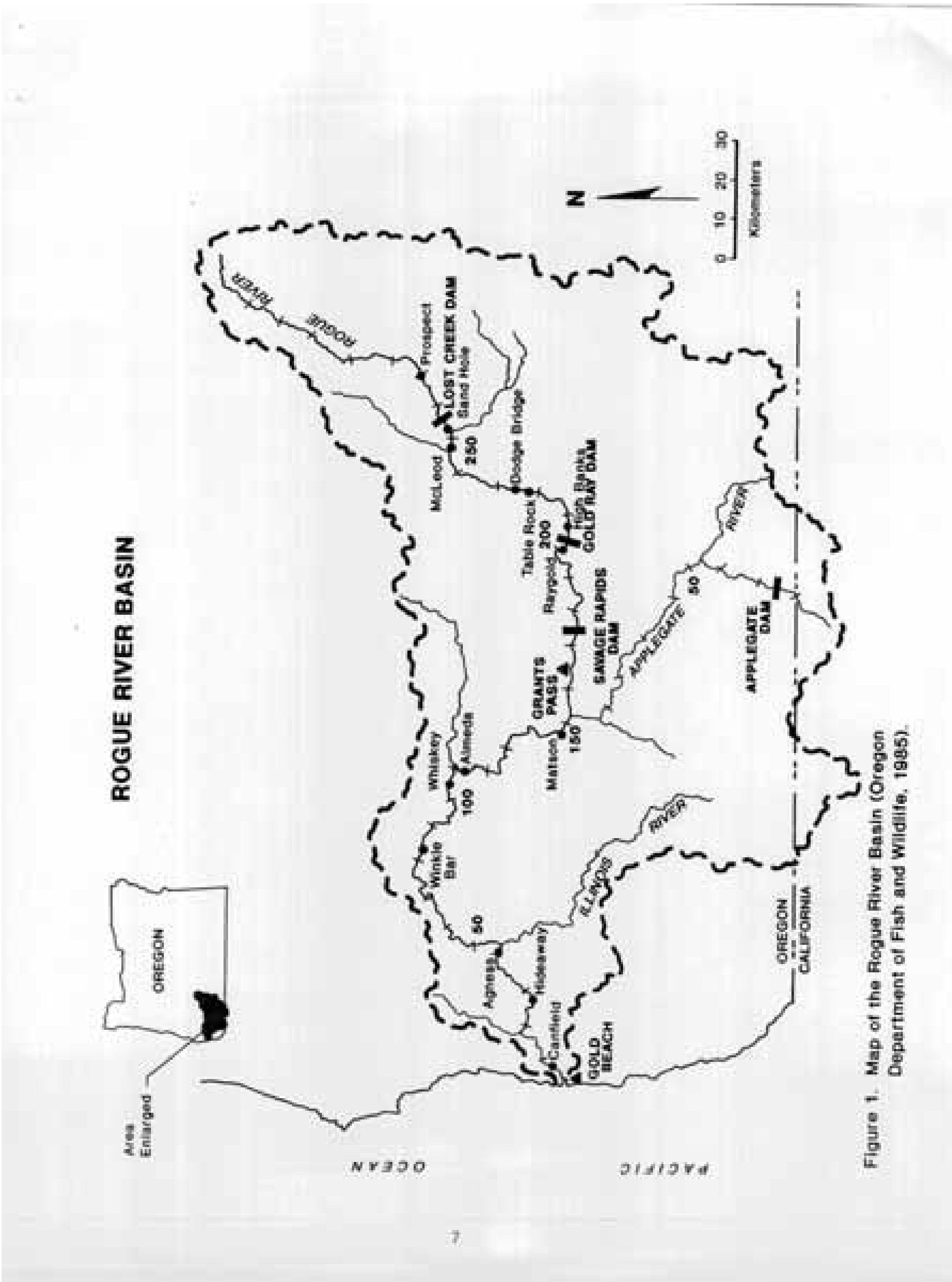

Figure 1. Map of the Rogue River Basin (ODFW 1995)

Figure 2. An aerial view of Savage Rapids Dam.

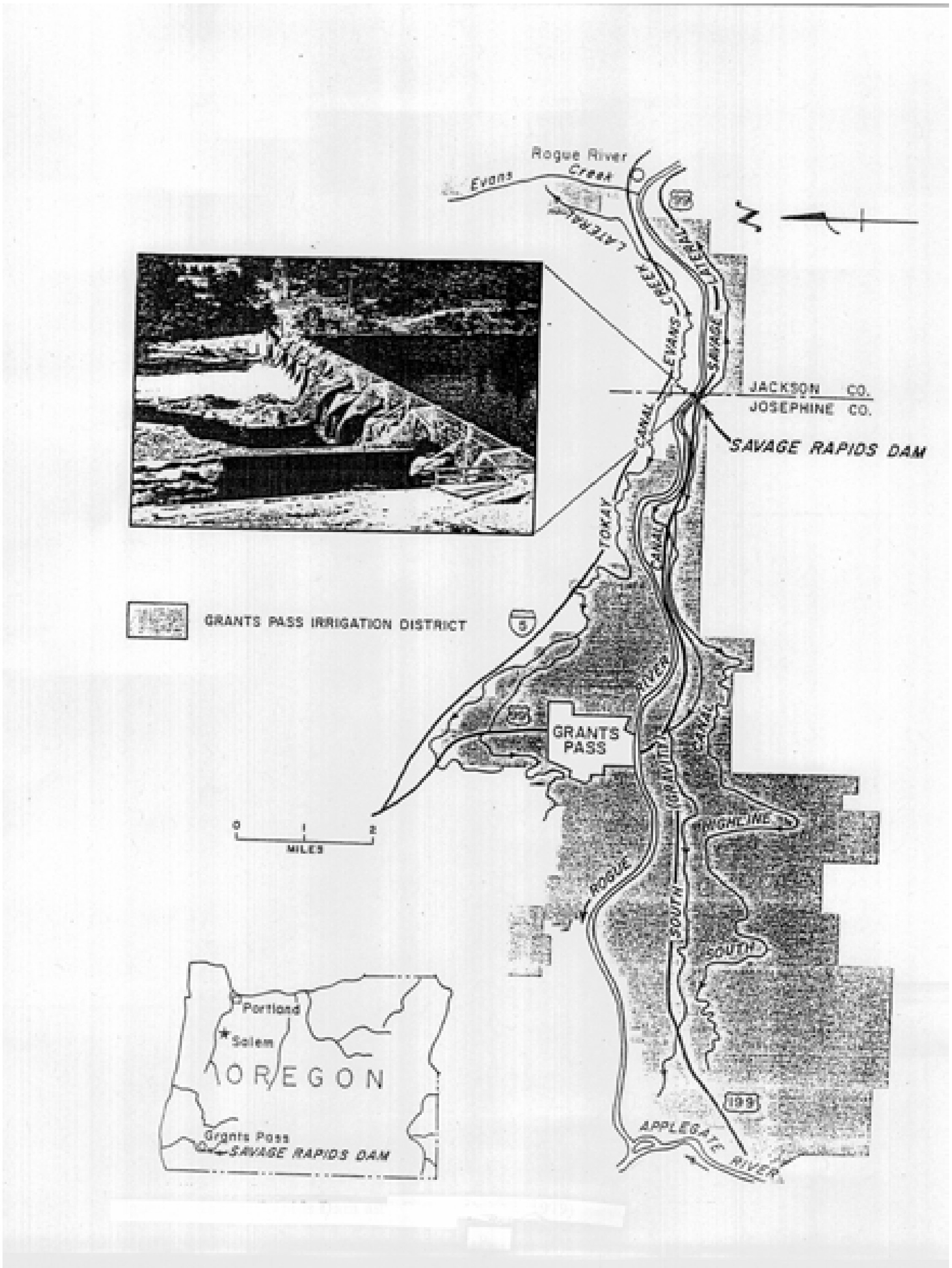

Figure 3. Configuration of GPID Service Area and Facilities.

DESCRIPTION OF THE PROJECT

Savage Rapids Dam, completed in 1921, is a concrete structure approximately 464 feet long and has a maximum height of 39 feet (Figure 4 and 5). The existing dam is composed of:

- A 16-bay overflow spillway (398 feet long and 11 feet deep),
- Two, 16-foot by 7-foot radial gates at bays 10 and 11,
- A hydraulically-powered pumping facility with fish screens on the north shore
- Two fish ladders, one on each shore; and,
- Gravity canal headworks on the south shore (Figure 6).

During the irrigation season, stoplogs are installed in the spillway bays to raise the river surface elevation behind the dam by 11 feet. This allows diversion to be made by gravity through the canal headworks and by pumping with direct-connected hydraulic turbine-driven pumps to four canals at higher elevations. Fish facilities at the dam now include the north fish ladder and south fishway for upstream migrants, traveling screens, and a bypass system in the turbine-pump intake channels as well as rotary screens in the Gravity Canal to protect downstream migrants.

Engineering details of the specific structure, operations, and passage conditions at SRD have been presented in numerous documents in the past (FWS/USBR 1974, USBR 1976 and 1979) and are not repeated here. Table 1 shows a brief history of fish passage studies and construction activities that have occurred at the dam. Not all the interim fish passage measures recommended and funded by PL 93-493 were implemented (see 1977-81, Table 1). Although replacement of the north ladder was recommended and funded, the one bid received to do the work was substantially greater than the funds remaining, and, consequently, this work was never done (USBR 1981). In 1979 a decision was made to expend remaining funds on interim improvements until agreement and sufficient funds were available for a permanent solution. New fish screens on the north side and minor modifications to the south side ladder were completed in 1981. In 1984 further fisheries study was deferred because of uncertainties regarding potential hydropower development at SRD. The last fisheries improvement measures implemented at SRD were completed in 1986 with minor modifications to the south ladder made by local fishery groups, with overview by the ODFW.

Figure 4. Savage Rapids Dam, north side spill, major obstacle to upstream migration of salmon and steelhead.

Figure 5. Crest of dam-spill onto bedrock results in poor attraction of fish to ladders.

Figure 6. Photo of south shore gravity canal headwaters, looking upstream

Efforts by Reclamation to reinitiate feasibility level planning were delayed until 1988, when the Water Management Study began. The 1970's evaluation of fish passage problems at SRD led to the evaluation of two basic fish passage/water supply alternatives which was the basis for much of the work with the Water Management Study: 1) Dam retention with new fish facilities; 2) Dam removal with new pumping facilities. These are summarized below:

DAM RETENTION ALTERNATIVE

Replace north fish ladder, new screens on turbine and pump bays, replace south fish ladder, new south canal fish screens, stoplog modifications, plunge pool modification, new radial gates, juvenile fish trapping facility, public access facility. Reclamation estimated construction costs equal $17.6 million (1993 costs). These costs include the replacement of the existing pumps, turbines, and discharge lines, which have exceeded their useful service life, but not replacement of the cableway/stoplog system.

DAM REMOVAL ALTERNATIVE

Remove SRD and restore dam area and construct new pumping facilities (2) in the vicinity of the existing dam, with maximum capacity of 150 cfs discharge for peak use period. Reclamation estimated construction costs equal $11.2 million (1993 costs). This plan includes constructing a transmission line across the river at the pump sites.

Because of: 1) the additional costs for the dam retention alternative; 2) the additional fish passage benefits with dam removal (discussed later); 3) the concern for possible continued fish losses and long term need for high levels of operation, maintenance and replacement activities with dam retention (also discussed later); and 4) the support of the GPID board and Water Resource Commission for dam removal, the resource agencies believed dam removal coupled with the construction of new pumping facilities should be the preferred federal plan. This alternative was the recommended fish passage plan evaluated in the 1995 detailed report. This alternative remains the recommended fish passage plan of the resource agencies.

The Water Management Study results identified the need for pumping facilities sized to provide 150 cfs maximum discharge during the peak use month of August. Operationally, flows would range from a low of 100 cfs during startup and shutdown in April and October, 130 cfs in May and September and 150 cfs peak in August, with a seasonal average of 139 cfs. Anticipated monthly flow needs by canal are summarized in Table 2, with the system needs totaled.

Table 2. Anticipated monthly flow, in cfs, by canal, with the system needs totaled.

CANAL	MAY	JUNE	JULY	AUGUST	SEPT.	SEASONAL AVERAGE
TOKAY & EVANS	27.75	30.00	31.00	32.00	27.75	29.70
GRAVITY	51.25	55.25	57.00	59.00	51.25	54.75
HIGHLINE & SAVAGE	51.00	54.75	57.00	59.00	51.00	54.55
TOTAL	130.00	140.00	145.00	150.00	130.00	139.00

The original dam removal alternative included two pumping facilities, one on each side of the river, in the immediate vicinity of SRD utilizing existing rights-of-way. Flows would be delivered utilizing the existing distribution system. The pumping facilities would be constructed before the dam is removed to insure delivery of water to GPID and continuous fish passage. Coffer dams would be required on each side of the river to protect the construction sites for the pumping facilities. Construction scheduling is extremely important because species of anadromous fish are present in the Rogue River year round, sometimes in very large numbers. Schedules will be developed during the detailed design stage of implementation, and is the primary reason for updating the 1995 detailed report via this supplemental Fish and Wildlife Coordination Act Report.

As required by its water use permit conditions, numerous other measures were proposed to be implemented by GPID for systems, improvements and water conservation, and were adopted for implementation as approved by the Water Resources Commission in October, 1994. The proposed action of dam removal and replacement with pumping facilities is identified as a federal action because of the significant benefits to anadromous fish in the Rogue River basin. It was the only action evaluated in detail in the 1995 report.

CURRENT PREFERRED ALTERNATIVE

At this time, based on preliminary design and study since 1995, Reclamation has selected a preferred alternative, refined from the original 1995 dam removal alternative. This refined alternative is consistent with the objectives of the PR/FES and ROD. The elements of this alternative are:

- A single, indoor-style, multi-unit pumping facility located on the south riverbank immediately downstream of the existing south fish ladder. This facility would include an intake/fish screen structure that feeds water to the new pumping facility via buried pipes.

- A new 42-inch diameter discharge pipeline from the new pumping facility to the existing Highline/Savage Canal System located on the south side of the Rogue River.

- A new 42-inch diameter discharge pipeline from the new pumping facility to the existing Gravity Canal System located on the south side of the Rogue River.

- New canal headworks.

- A new 30-inch diameter cross-river pipeline to convey approximately 20 percent of the water from the new pumping facility to the Tokay/Evans Canal System on the north side of the river. The cross-river pipeline will include a new pre-engineered pipe support bridge across the Rogue River.

- A 69-kilovolt substation on the south side of the Rogue River, designed to supply power for the new pumping facility via access from PacifiCorp's primary voltage transmission line adjacent to the site.

- Removal of the existing dam structures on the north side of the dam (bays 1 through 11) down to (but not below) the elevation of the existing apron in the main river channel with the abutment structures and a portion of the south side of the dam (bays 12 through 16) left in place (referred to as partial dam removal) thus removing the impediments to fish passage.

Figure 7 is a preliminary design depicting the location of the new, single, pumping facility on the south side of the Rogue River, and the sections of the existing dam scheduled to be removed.

Figure 8 depicts an artist rendition of the Project after the dam removal activities are completed.

CONSTRUCTION SCHEDULE

Based on current information, the proposed schedule for construction of the new pumping facility, scheduled for 2006, would be within the recommended State of Oregon in-water work window (June 15 to August 31), as outlined in state guidelines.

The construction of the new substation, the new cross-river pipe support bridge and new canal headworks (scheduled for 2006 through 2007) would not include any inwater work, based on current information.

During 2008-2009, to accommodate the construction schedule for partial removal of the dam, Reclamation has proposed:

- Use the existing radial gates to draw down the reservoir from June 16 to July 8, 2008. This is intended to facilitate the placement of cofferdams and access roads necessary to complete dam removal on the north side of the dam.
    - The upstream cofferdam and access road on the north side of the dam would be built in the "dry".
    - The downstream cofferdam on the north side of the dam would be built in the "wet".
    - The existing fish ladders would be inoperable. Fish passage would be through the radial gate openings.

- Close radial gates to refill reservoir for fish passage through south fish ladder. The lower portion of the south fish ladder will be operable to allow passage of fish, as is currently done during the non-irrigation season.

- Dam removal on the north side of the dam is estimated to take 18 weeks to complete (July 8 to November 7, 2008).
    - Excavation of sediments from reservoir immediately upstream of dam in the "dry".
    - Removal of north side of dam (bays 1-7) in the "dry".

- Use the existing radial gates to draw down the reservoir from November 7 to November 26, 2008.
    - This is intended to facilitate the removal of sheetpiles in the cofferdams and allow for construction of the pilot channel. The pilot channel would be located in the upstream and downstream cofferdams.
    - Fish passage would be through the radial gate openings.

- After November 26, the river is allowed to flow in the pilot channel.
    - Fish passage is via the new "river channel".
    - River flow removes cofferdams, upstream access road and reservoir sediments during winter high flow events.

- Build access road and cofferdam on the south side of the dam during first two weeks of normal in-water work period (June 16 to June 26, 2009).
    - Cofferdam would be built in the "wet".

- Dam removal on the south side of the dam is estimated to take 7 weeks to complete (June 29 to August 17, 2009).
    - Removal of south side of dam (bays 8 through 11) in the "dry".

- Removal of cofferdam between August 18 and August 24, 2009.

Reclamation is proposing to remove a gravel/debris deposit from in front of the new pumping plant. Removal of this deposit is necessary to provide appropriate river flow conditions in front of the pumping facility intake (Figure 9).

Reclamation is considering once bays 1 through 9 have been removed and the river flow has been redirected through that area, the radial gates will be removed and the openings will be plugged with concrete. This is to assure better flow conditions past the new pumping facility intake (flow through the radial gate channel would tend to create swirling conditions in front of the new pumping facility fish screens).

Reclamation is considering giving the contractor the option of: 1) disposing of concrete rubble from dam demolition in the radial gate channel (diversion channel) both upstream and downstream of the dam axis, or 2) transporting the concrete rubble to an approved upland disposal site. If the contractor chooses to use the concrete rubble to fill the existing diversion channel, the contractor would be required to cap the rubble with "dental" concrete to assure the rubble stays in place during future flood flows. The placement of concrete rubble in the diversion would be conducted in the "dry".

Reclamation also plans to plug the opening in the back wall of the south fish ladder that leads to the so-called "high flow" fish ladder. This is necessary to provide a dry construction site for the new pumping plant. This portion of the fish ladder would be removed to make way for the pumping facility and its intake (Figure 10).

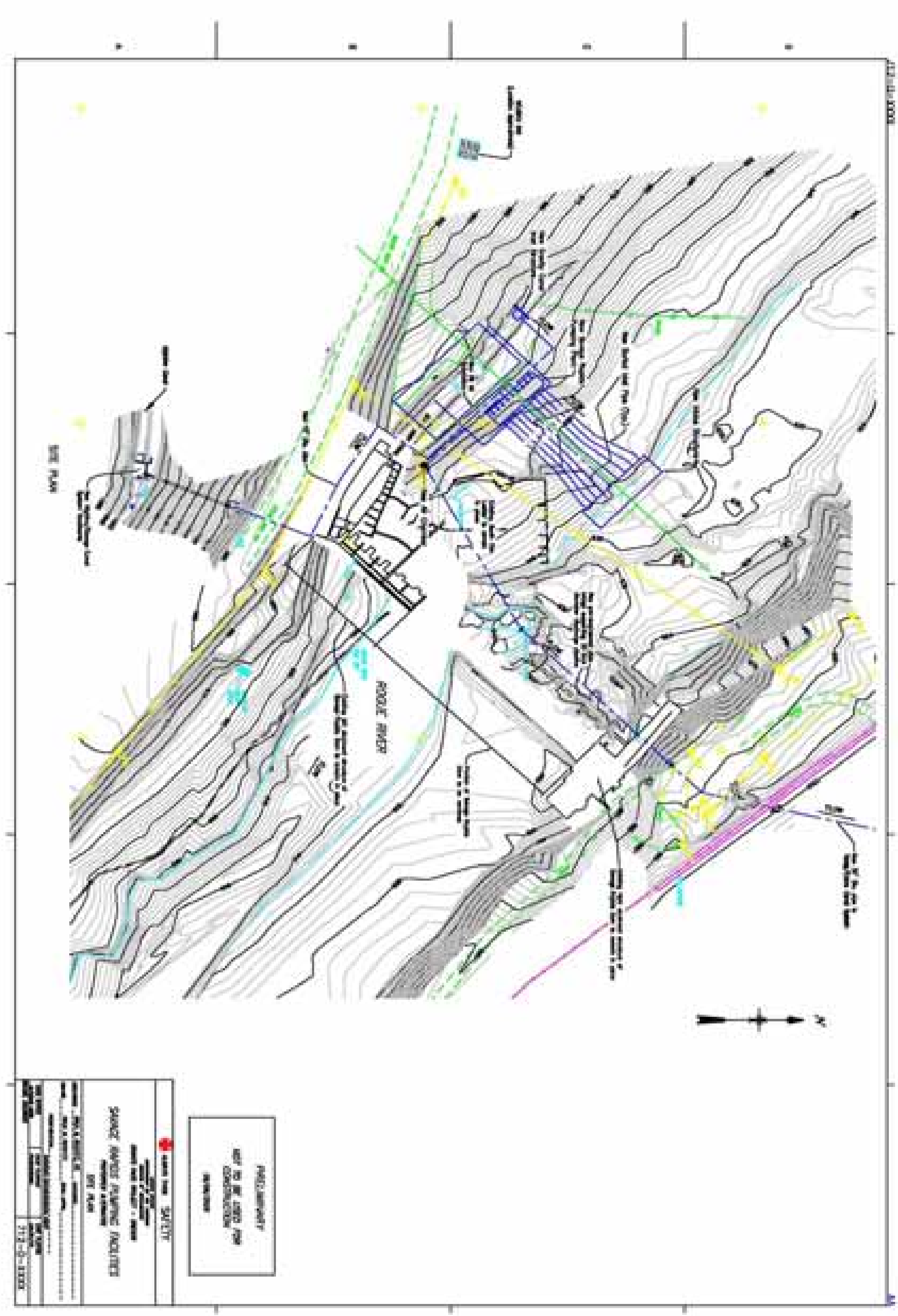

Figure 7. Preliminary design of current preferred alternative, showing new pumping facility and sections of existing dam scheduled for removal.

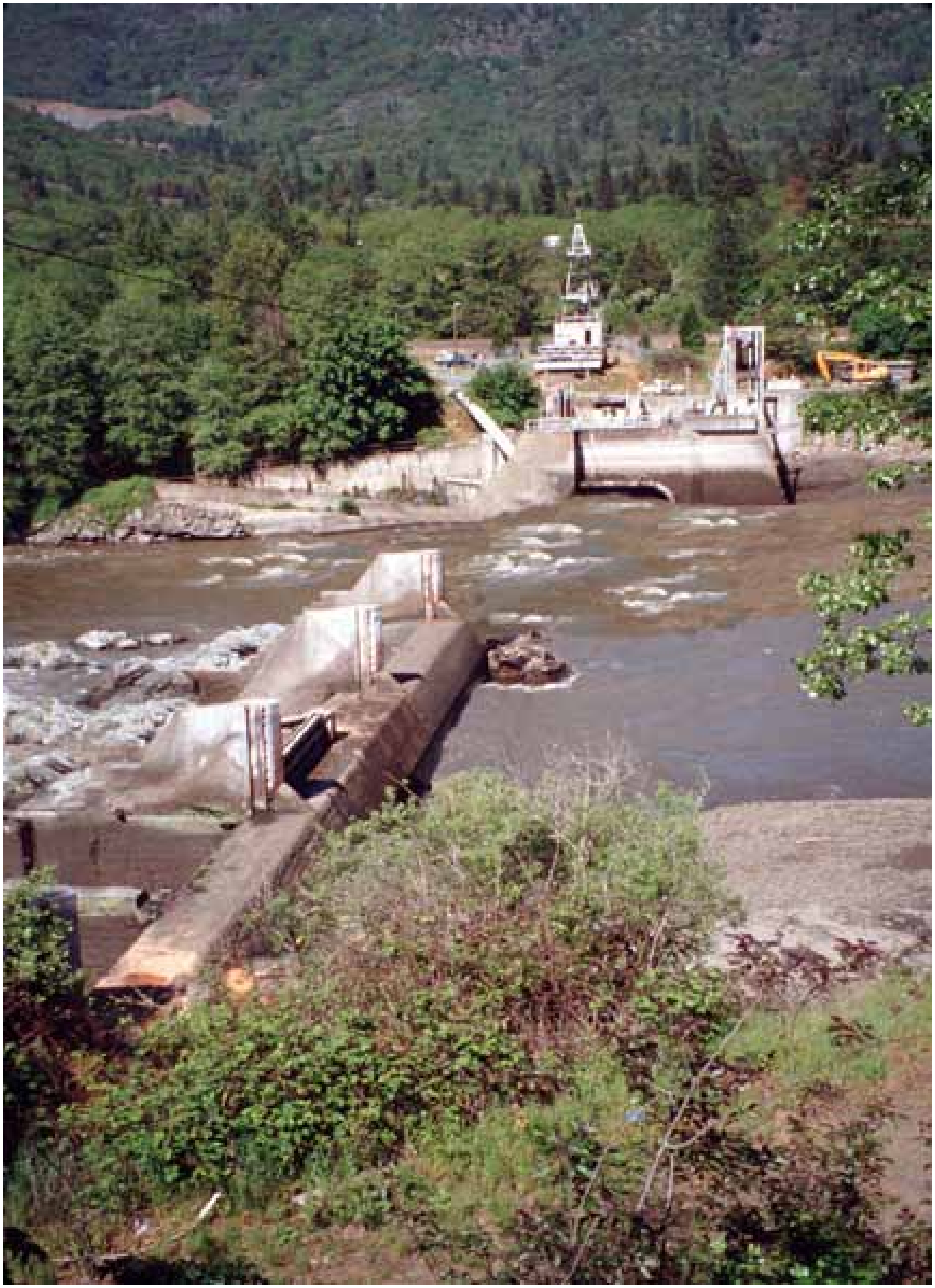

Figure 8. Artist Concept of Savage Rapids Dam after Project.

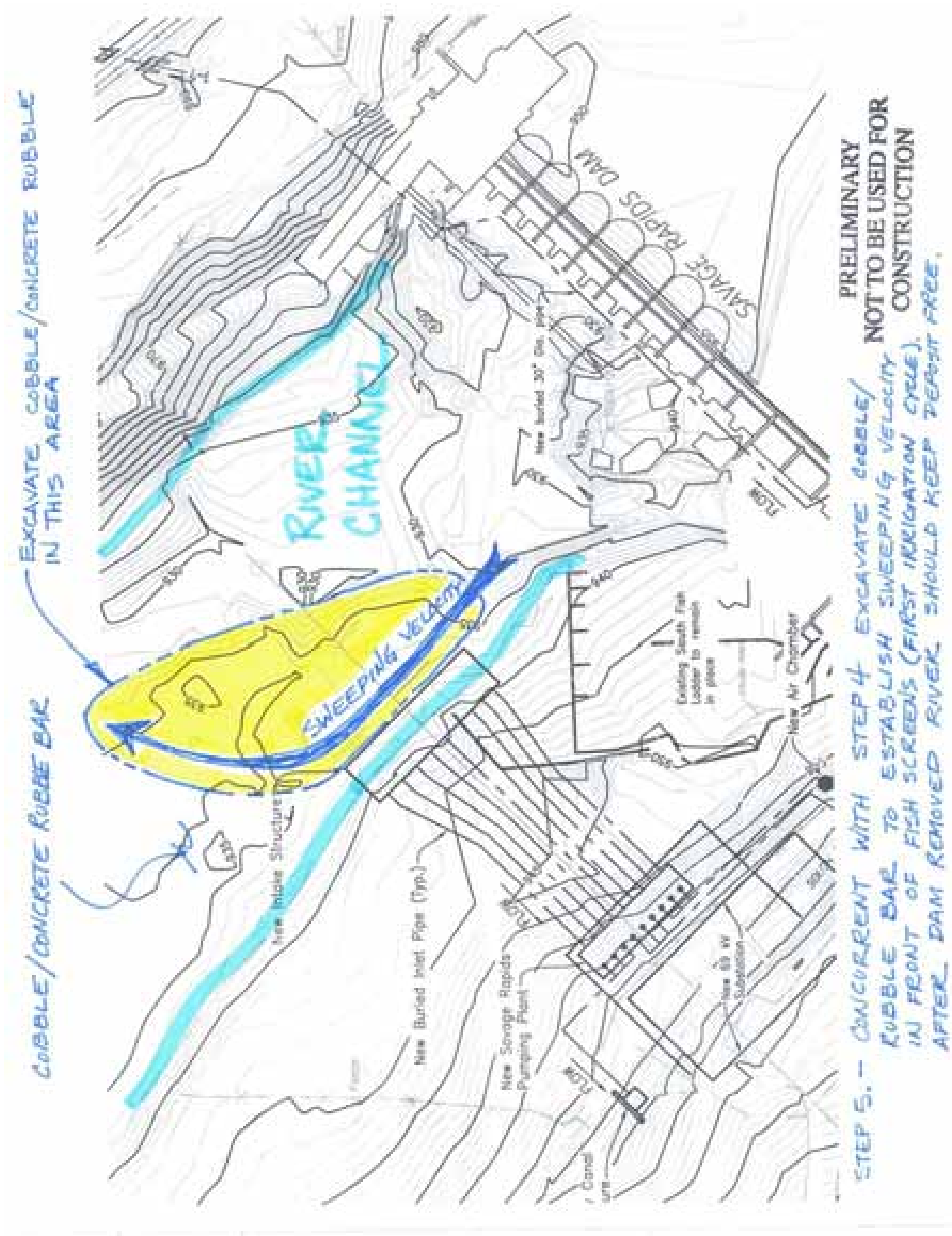

Figure 9. Preliminary site design for Savage Rapids Dam Removal Project, showing location of existing gravel/debris bar in front of new pumping plant.

Figure 10. Photo looking downstream along the south fish ladder, showing location of opening in fish ladder.

BIOLOGICAL RESOURCES

EXISTING CONDITIONS

FISH

The Rogue River basin supports a large population of anadromous salmonids, including spring and fall Chinook salmon, coho salmon, summer and winter steelhead, and cutthroat trout (Table 3). Chinook salmon and steelhead are the most plentiful species while cutthroat trout are least abundant and occur primarily in the lower river. In 1995, about 375,000 anadromous salmonids were produced annually, valued at $31.5 million (1994 dollars)(ODFW 1995). This included about 162,000 Chinook salmon harvested annually by sport and commercial fishermen and about 95,000 steelhead caught by sportsmen in the Rogue River (ODFW 1988). The Rogue River fisheries are not only attractive to residents of the northwest, but are nationally renowned for their diversity and productivity. An ODFW administrative rule for wild fish management (OAR 635-07-525) contains a policy giving protection and enhancement of wild stocks first and highest consideration. In 2002, the State of Oregon's Wild Fish Policy was replaced by the Native Fish Conservation Policy, which guides ODFW fish management actions. The Rogue River basin supports the largest wild population of anadromous salmonids in Oregon (ODFW 1988). Wild fish have made up more than 90 percent of the fall Chinook salmon and winter steelhead, and accounted for about 50 percent of the spring Chinook salmon, coho salmon and summer steelhead that return to the Rogue River. The production of hatchery fish in the basin is intended to mitigate the loss of habitat upstream of Lost Creek and Applegate Dam, both part of the Corps of Engineers (Corps) Rogue Basin Project.

Generally, on a coast wide basis throughout the Pacific Northwest, salmon and steelhead stocks have been at very depressed levels and several anadromous salmonids species in the region are listed, or are now candidates for listing, under the Act. Coho salmon stocks were especially hard hit by poor ocean survival conditions associated with El Nino events in the 1980's and 1990's, as well as more locally distributed Chinook salmon stocks such as Klamath River, southern Oregon (some Rogue populations included) and Columbia River Tule stocks. The ocean and inriver fisheries have experienced extremely restricted, or in some cases, completely forgone seasons since 1994 because of the conservation crisis facing many of these stocks. These restrictions included no ocean sport or commercial harvest for coho salmon and only limited commercial or inriver sport harvest for Chinook salmon.

In March 1991, the American Fisheries Society provided a list of depleted Pacific salmon, steelhead, and searun cutthroat stocks, and found Rogue River coho salmon were at a high risk of extinction, and the summer steelhead were at moderate risk of extinction. Reasons for decline of these species were listed as:

- The destruction, modification, or curtailment of its habitat or range. (In addition to habitat damage, this category includes mainstem passage and flow problems and predation during reservoir passage or residence.)

- Over utilization for commercial, recreational, scientific, or educational purposes. (This category includes overharvest in mixed-stock fisheries).
- Other natural or man-made factors affecting its continued existence, hybridization, introduction of exotic or translocated species, predation not primarily associated with mainstem passage and flow problems, competition. (This category includes negative interactions with hatchery fish, such as hybridization, competition and disease. Also included here are poor ocean survival conditions).

Within the Rogue River basin, winter steelhead of the Illinois River were petitioned for listing, but NMFS found that this stock did not qualify for protection under the Act because it did not meet the definition of a "species". The NMFS did initiate a status review of all steelhead runs along the west coast (exclusive of the Columbia River), and on March 16, 1995, proposed that the Klamath Mountain Province (KMP) steelhead be listed as a threatened species under the Act. The KMP steelhead was determined to be a discrete Evolutionary Significant Unit (ESU) with a distinct life history pattern (half-pounder returns) that includes all stocks of steelhead between Cape Blanco, Oregon and Cape Mendocino, California (NMFS 1995). This ESU includes both the summer and winter run steelhead in the Rogue River. The proposal found that most of the steelhead populations with the ESU were in significant decline, even with hatchery production included, and that there were not likely any naturally self-sustaining populations. Reasons for decline were a combination of logging, mining, agriculture, municipal, industrial, and agricultural dams (including some with no passage or poor passage conditions), harvest and/or hatchery practices, and poor ocean survival conditions. Critical habitat was not proposed in this rulemaking and will be proposed separately. On March 28, 2001, NMFS determined that listing of KMP steelhead was not warranted (NMFS 2001).

The NMFS found a petition to list coho salmon throughout its range in Oregon, Washington, California, and Idaho was warranted, and underwent a 1-year status review that was completed in late 1994. In May 1997, NMFS listed the Southern Oregon Northern California (SONC) coho salmon ESU as threatened under the Act. The SONC coho salmon ESU extends from Cape Blanco in southern Oregon to Punta Gorda in northern California and includes the Rogue River (Weitkamp *et al.* 1995).

Since most of the detailed study of fish passage issues at SRD were completed in the 1970's (Table 1), numerous studies of the Rogue River fisheries have been completed or are ongoing by ODFW in conjunction with the Corps' Rogue River Basin Project. Project features that affect either the basins fisheries, or actual passage conditions at SRD, include Lost Creek Dam at RM 157 on the mainstem Rogue River, the partially completed Elk Creek Dam on Elk Creek (a tributary at RM 152), Applegate Dam on the Applegate River (a tributary just downstream of Grants Pass) and Cole M. Rivers Fish Hatchery, located downstream of Lost Creek Dam.

The fish hatchery was constructed to mitigate for the impacts of the Rogue Basin Project on anadromous fish. The hatchery is operated by the ODFW. The mitigation goal for the hatchery is based on pounds of fish produced. It historically produced about 2 million spring Chinook salmon (smolts and pre-smolts); 200,000 coho salmon; and 150,000 each of summer and winter steelhead. Releases of spring Chinook salmon pre-smolts began in 1984, peaked with a release of 800,000 in 1987, but were discontinued in 1989 because of concerns with residualism impacting wild fish. Some fall Chinook salmon were also released from 1982-1987 to study distribution in the ocean fishery, but these releases (averaging about 34,600/yr for the period) were discontinued. The production of 150,000 summer and winter steelhead 1-year old smolts has also been discontinued.

Currently, the hatchery produces 1.6 million Spring Chinook salmon smolts and 200,000 coho salmon smolts. Current summer steelhead production is 220,000 smolts and 264,000 2-year old winter steelhead smolts. The winter steelhead production is split between the Rogue and Applegate rivers (Dan Van Dyke, pers. comm. 2005). All fish produced for the Rogue River are released at the hatchery, while Applegate River fish are trucked to that river and released.

Lost Creek Dam has been operational since 1977 and provides flows and temperature control to enhance anadromous fish. Elk Creek Dam construction was started in 1986 and has since been stopped by court order. Elk Creek Dam is about 50 percent complete and fish passage is still being provided for at the dam since flows are not being regularly impounded and significant habitat is available upstream in the basin. A fish trap and haul facility constructed downstream is being used by Corps to collect fish for relocating upstream. It is anticipated that this facility will be used on a permanent basis until a final decision and plan of operation (or removal) is developed for Elk Creek Dam.

In 2001, NMFS completed an analysis and consultation, pursuant to Section 7 of the Act, regarding the Elk Creek Dam fish passage alternatives. The NMFS concluded, in their biological opinion, only the dam breeching alternative would avoid jeopardizing the continued existence of SONC coho salmon.

Although Lost Creek and Applegate dams are primarily for flood control, another major purpose of the Rogue River Basin Project is to enhance anadromous fish runs. An important part of this effort has been to monitor and evaluate project operations and fishery resources to develop specific recommendations on how best to operate the projects and meet the intended purposes of fishery enhancement – or at the very least avoid conditions that would be detrimental to the production and harvest of wild salmon and steelhead. A brief list of the Rogue River Basin Fisheries Evaluation Studies conducted by ODFW and funded by the Corps is presented in Table 4.

How anadromous fish are affected by passage conditions at SRD is a function of numerous factors, i.e., the number, size, and condition of fish at the dam; time of year and particular water conditions (high or low flows, spill, rate of pumping, radial gates open or closed, leaders in operation); and the efficiency of the fish facilities in providing optimum passage conditions (good attraction flows, regulated and consistent flows through the ladders, appropriate screen velocities, tight seals and no places for delay or injury, etc.) These are discussed in greater detail below for the existing conditions at SRD.

Table 3. Estimated number of salmon and steelhead migrating over Gold Ray Dam, Rogue River.

Return year	Spring Chinook salmon	Fall Chinook salmon	Coho salmon	Summer steelhead	Winter steelhead
1942	41,779	1,670	4,608	7,387	--
1943	36,136	1,611	3,290	5,648	15,314
1944	30,632	1,223	3,230	5,530	13,380
1945	31,996	1,641	1,907	7,302	16,083
1946	28,374	1,691	3,840	4,448	8,729
1947	33,637	1,176	5,340	3,221	9,653
1948	26,979	757	1,764	2,133	8,605
1949	18,810	1,233	9,440	3,618	8,052
1950	15,530	1,204	2,007	4,583	8,684
1951	19,443	1,489	2,738	3,262	5,744
1952	15,888	2,558	320	4,200	10,648
1953	31,465	2,083	1,453	3,831	10,945
1954	24,704	955	2,138	2,222	7,228
1955	15,714	836	480	1,703	5,239
1956	28,068	1,884	421	2,753	8,775
1957	17,710	1,060	1,075	1,323	4,508
1958	15,016	700	732	1,293	3,855
1959	13,972	735	371	865	4,550
1960	24,374	1,843	1,851	2,034	6,901
1961	31,775	1,260	232	2,408	8,965
1962	31,395	1,265	457	3,603	9,901
1963	40,567	960	3,831	1,508	9,024
1964	37,327	1,137	168	778	6,431
1965	47,644	1,776	482	2,144	7,310
1966	31,422	1,166	178	2,092	12,463
1967	14,693	1,800	89	1,637	5,150
1968	19,469	912	149	693	7,235
1969	59,043	2,190	530	7,768	6,559
1970	45,101	3,068	160	6,088	13,789
1971	29,473	2,407	181	4,909	9,442
1972	30,788	2,756	185	3,559	16,826
1973	35,276	3,816	193	5,236	9,566
1974	17,006	2,309	146	7,858	7,108
1975	21,483	2,312	154	8,338	10,367
1976	21,570	2,648	44	3,529	6,048

Return year	Spring Chinook salmon	Fall Chinook salmon	Coho salmon	Summer steelhead	Winter steelhead
1977	16,403	5,181	522	11,352	4,724
1978	47,221	5,878	756	4,977	7,867
1979	38,207	3,093	1,744	14,867	12,767
1980	36,932	2,906	5,617	7,773	13,371
1981	17,213	4,767	6,725	11,929	8,197
1982	29,942	4,595	670	13,654	6,337
1983	12,511	3,839	1,493	7,581	9,728
1984	12,690	3,184	3,236	7,397	9,486
1985	40,545	8,455	1,170	7,511	10,462
1986	89,522	14,239	4,072	14,598	16,664
1987	81,581	10,699	5,395	24,955	17,587
1988	82,591	11,497	6,882	19,283	15,019
1989	60,332	6,903	1,401	12,411	14,595
1990	24,589	3,650	697	5,959	10,487
1991	12,350	3,205	2,562	4,975	4,547
1992	5,801	6,797	4,006	3,507	4,134
1993	26,103	6,711	3,486	10,595	6,479
1994	14,076	11,530	10,699	11,085	6,581
1995	81,951	14,366	13,518	13,894	12,434
1996	36,621	11,385	13,599	11,680	9,168
1997	41,794	4,857	15,750	7,538	14,957
1998	15,957	5,332	6,044	6,056	5,029
1999	20,981	3,540	7,722	4,785	9,497
2000	30,265	9,892	28,791	6,734	6,807
2001*	33,273	13,606	32,962	16,114	8,944
2002*	47,781	19,823	34,154	29,296	22,287
2003*	41,841	24,857	17,179	20,297	24,850
2004*	39,243	15,007	21,702	13,658	21,889
10 YR AVE.	38,971	11,919	18,042	12,748	13,586
AVE. ALL YRS	32,104	4,563	4,597	7,102	9,967

* PRELIMINARY, SUBJECT TO REVISION   Revised: 2/8/2005

Count Periods

Spring Chinook Salmon	March 1	to	August 15
Fall Chinook Salmon	August 16	to	January 15
Coho Salmon	September 15	To	January 30
Summer Steelhead	May 15	To	December 31
Winter Steelhead	January 1	To	May 15

Table 4. A brief chronology of Rogue River Basin Fisheries Evaluation studies conducted by ODFW for Lost Creek and Elk Creek Dams.

YEAR	ITEM
1973	Smolt physiology and hatchery studies started.
1974	Lost Creek Dam filed studies started:
	spring Chinook fall Chinook salmon summer steelhead winter steelhead coho salmon water chemistry benthic biology salmonids genetics
1976	Salmonid genetics study completed.
1976-77	Lost Creek Dam closure study conducted.
1977	Water chemistry and benthic biology studies completed. Hatchery evaluation funding taken over by Service.
1979	Smolt physiology study completed.
1980-82	Study with OSU on fall Chinook salmon mortality conducted.
1981	Lost Creek Dam winter steelhead sampling completed. Lost Creek juvenile sampling reduced. Creel surveys reduced.
1985	Lost Creek Dam fisheries evaluation Phase I Completion Report.
1986	Lost Creek Dam fall Chinook salmon, summer steelhead, and coho salmon sampling completed.
1987	Elk Creek Dam studies started.
1988	Studies remaining are Elk Creek Dam and Lost Creek Dam spring Chinook salmon.
1988-91	Elk Creek Dam fisheries evaluation—Annual progress reports.
1990	Lost Creek Dam effects on winter steelhead, Phase II Completion Report.
1991	Lost Creek Dam effects on coho salmon, Phase II Completion Report.
1992	Lost Creek Dam effects on fall Chinook salmon, Phase II Completion Report.
1993	Elk Creek Dam fisheries evaluation—Completion Report.
1994	Lost Creek Dam effects on summer steelhead, Phase II Completion Report.

The total numbers of adult anadromous fish passing SRD for the earlier studies (NMFS 1979 and Service 1981) were estimated to be 120,500, including 49,700 spring Chinook salmon; 8,500 fall Chinook salmon; 1,000 coho salmon; 37,300 summer steelhead; and 24,000 winter steelhead. This was assumed to be about 45 percent of the total spawning population in the basin at the time. Figures from the early 1990’s for the Rogue River basin estimate a total return of adults to freshwater of about 260,000 fish, including 30,000 spring Chinook salmon; 45,000 fall Chinook salmon; 8,000 coho salmon; 130,000 summer steelhead (includes half-pounders); and 47,000 winter steelhead (ODFW 1992). Using the same percentage of inriver harvest and distribution spawners upstream of SRD as earlier studies, the 1995 report estimated adult returns from 1982 to 1993 would breakdown as a total of 90,100 adults upstream of SRD, which includes 36,940 spring Chinook salmon; 6,880 fall Chinook salmon; 810 coho salmon; 38,420 summer steelhead; and 17,050 winter steelhead.

While these numbers suggest lower estimates than the earlier figures (pre-1982), and the late 1980's and early 1990's were at depressed levels (ODFW 1994), the concern was raised in earlier studies (Service 1990) that changes in the Rogue River with operation of the Lost Creek Project and Cole Rivers Hatchery would increase the number of fish subject to passage problems at SRD.

A better, more long-term indicator of fish numbers at SRD is the counts at Gold Ray Dam (GRD). Fish counts at GRD (RM 125, 18 miles upstream) are a good indicator of fish numbers passing SRD except for fall Chinook and coho salmon and steelhead, because mainstem spawning areas occur on the Rogue River between the two dams (ODFW 1985). Evans Creek is the only major tributary in that reach and it receives some fall Chinook and coho salmon and significant steelhead use. Thus, figures for fall Chinook and coho salmon and steelhead at GRD would be less than numbers at SRD. ODFW estimated about three times as many fall Chinook salmon spawning between the dams compared to the average count at GRD (for the 1942-94 period) (ODFW 1995). The Gold Hill area, including Evans Creek is a major producer of summer steelhead, with fish spawning in numerous tributaries to Evans Creek (ODFW 1990). The mainstem of Evans Creek is used by winter steelhead. The ODFW estimate of numbers of spawning summer and winter steelhead between the two dams, as compared to their average counts at GRD (1942-93 period) were 60 percent and 43 percent respectively (ODFW 1995).

Table 5 shows a comparison of earlier estimates of SRD passage with counts at GRD, for the high and low year counts, as well as the ten year average and total period average from 1942 to 1993. These figures show that the earlier estimates of passage at SRD more closely match numbers of escapement during periods of large returns, and are substantially greater than low return years or the long term average (realizing that the differences are not as great as shown because of fall Chinook salmon and steelhead production between SRD and GRD). For this analysis the resource agencies recommend that counts at GRD be used as a direct indicator of numbers of adult fish passing SRD.

This will allow a risk analysis based on the wide range in the numbers of returning adults annually and the associated wide range in benefits. This evaluation is presented in the "with the project" section of the report. While numbers will be conservative, substantially underestimating passage for fall Chinook salmon and to a lesser extent, summer steelhead and winter steelhead, they are based on actual counts of fish over a long period of time.

Fish Counts at Gold Ray Dam 1995 to 2004

Coho salmon
For the 10-year period from 1995 to 2004, counts of adult coho salmon at GRD have ranged from 6,044 in 1998, to 34,154 in 2002. The 10-year average is 18,042 (Table 3).

This is a significant increase in fish passing GRD and could be attributable to better ocean conditions, freshwater habitat improvements and/or overall fish survival. Since 1995, estimates of wild adult coho salmon passing GRD have ranged from 1,310 in 1998-1999 to 15,652 in 2000-2001 (Table 6). The portion of the wild fish has ranged from 18 percent to over 50 percent. Since 1980, the wild component of the coho salmon run passing GRD has been highly variable, ranging from eight percent (1991) to 89 percent (1982) (Appendix A). Estimates of wild coho salmon at Huntley Park (RM 6) during this same time range from 18 percent (1980) to 83 percent (1982) (Appendix A).

Table 5. Comparison of adult fish passage at Savage Rapids Dam (Service 1981) with counts at Gold Ray Dam for a high, low, 10-year average (1985-94) and the 53-year period of record (1942-1994).

Savage Rapids Dam		Gold Ray Dam			
		High year	Low year	10-yr. Avg.	53-yr. Avg.
Species	FWS 1981	1987	1959	1985-1994	1942-1994
Spring Chinook salmon	49,700	81,581	13,972	43,740	30,809
Fall Chinook salmon	8,500	10,699	735	8,386	3,306
Coho salmon	1,000	5,395	371	4,036	2,176
Summer Steelhead	37,300	24,955	865	11,488	6,112
Winter Steelhead	24,000	17,587	4,550	10,656	9,271
TOTALS	120,500	140,217	20,493	78,306	52,907

Spring Chinook salmon
For the 10-year period from 1995 to 2004, counts of adult spring Chinook salmon at GRD have ranged from 15,957 in 1998, to 81,951 in 1995. The 10-year average is 38,971 (Table 3).

Steelhead
For the 10-year period from 1995 to 2004, counts of adult steelhead (winter and summer) at GRD have ranged from 11,085 in 1998, to 51,583 in 2002. The 10-year average is 26,334 (Table 3).

Migration Timing

Coho Salmon
Adult coho salmon migrate through the action area between late September and January. Approximately 85 percent of the adult coho salmon passing GRD do so from mid-October through the end of November (Table 7). Approximately 70 percent of the adult

coho salmon pass SRD during November. Conversely, less than two percent of the adult coho salmon pass SRD before mid-October (Table 7 and Figure 11).

Table 6**.** Estimate of Adult SONC Coho Salmon (wild fish as identified by ODFW) at Gold Ray Dam, 1993-2004 (ODFW data).

Year (counts from 9/15-1/31)	Wild coho salmon at GRD	Total Coho salmon at GRD	Percent Estimated to be Wild
1993-94	756	3,486	22
1994-95	3,265	10,699	31
1995-96	3,345	13,518	25
1996-97	2,554	13,599	19
1997-98	4,566	15,750	29
1998-99	1,310	6,044	22
1999-2000	1,417	7,722	18
2000-2001	15,652	28,791	54
2001-2002	12,717	32,962	39
2002-2003	11,512	34,154	34
2003-2004	6,588	17,179	38
2004-2005	11,481	21,702	53

Juvenile coho salmon are known to be present in and migrate through the project area portion of the Rogue River. The spring out-migration occurs from April through June in the project area.

Studies associated with the Rogue River Basin Fisheries Evaluation (ODFW 1991) found the mean migration of yearling coho salmon passing Savage Rapids to peak in late May to mid-June in the years 1975-1986, although cool temperatures in water releases at Lost Creek were mentioned as a possible delaying factor in migration timing. Peak catches of wild coho salmon yearling during seining at High Banks (RM 129) between 1983 and 1990 varied between April 28 and June 6, except for 1986, when good numbers were caught before April 20 (Tom Satterthwaite, pers. comm. 2005). The catch of wild coho salmon yearling at an irrigation diversion in the Rogue near Table Rock (RM 134) in 1983 peaked between April 21 and May 9 (Tom Satterthwaite, pers. comm. 2005).

More recent data on migration timing of juvenile coho salmon in tributary streams has been collected through the interagency Upper Rogue Smolt Trapping Project, conducted on six tributary streams since 1998 with the primary involvement of ODFW, BLM and the USFS. The peak migration of coho salmon smolts has ranged from late April to late May in Bear Creek, Little Butte Creek and West Evans Creek (Figure 12). All three tributaries are located above SRD, while the Little Applegate River, Slate

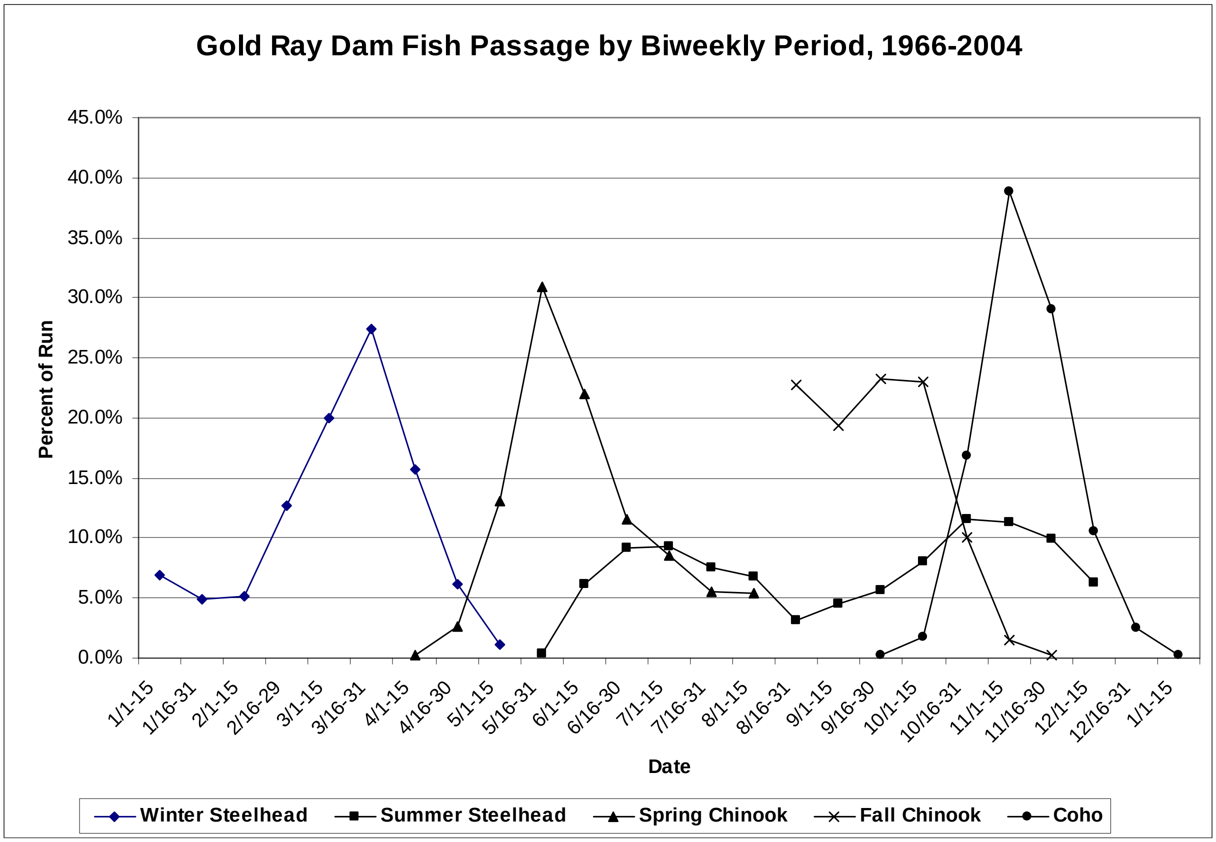

Figure 11. Adult Salmonid run timing at Gold Ray Dam 1966 – 2004.

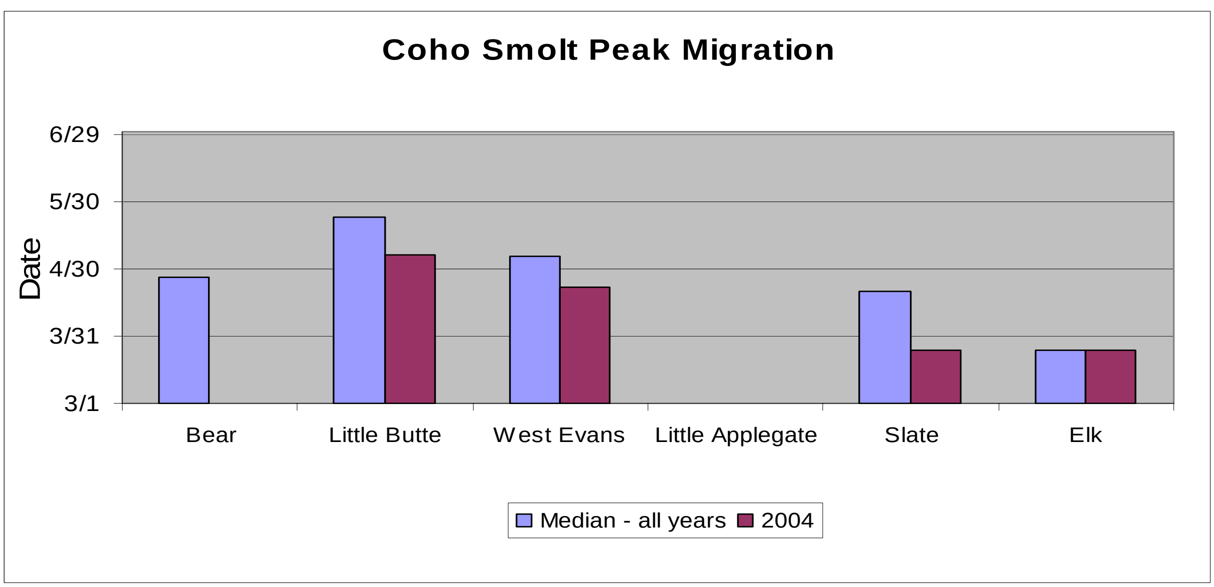

Figure 12. Coho Salmon Smolt migration timing. The median encompasses years 1998-2004. (Taken from Figure 13, ODFW 2004).

Creek and Elk Creek (a tributary to the Illinios River) are located downstream of SRD. A graph of the peak week of outmigration by tributary during the project was included in the ODFW 2003 report (Figure 13).

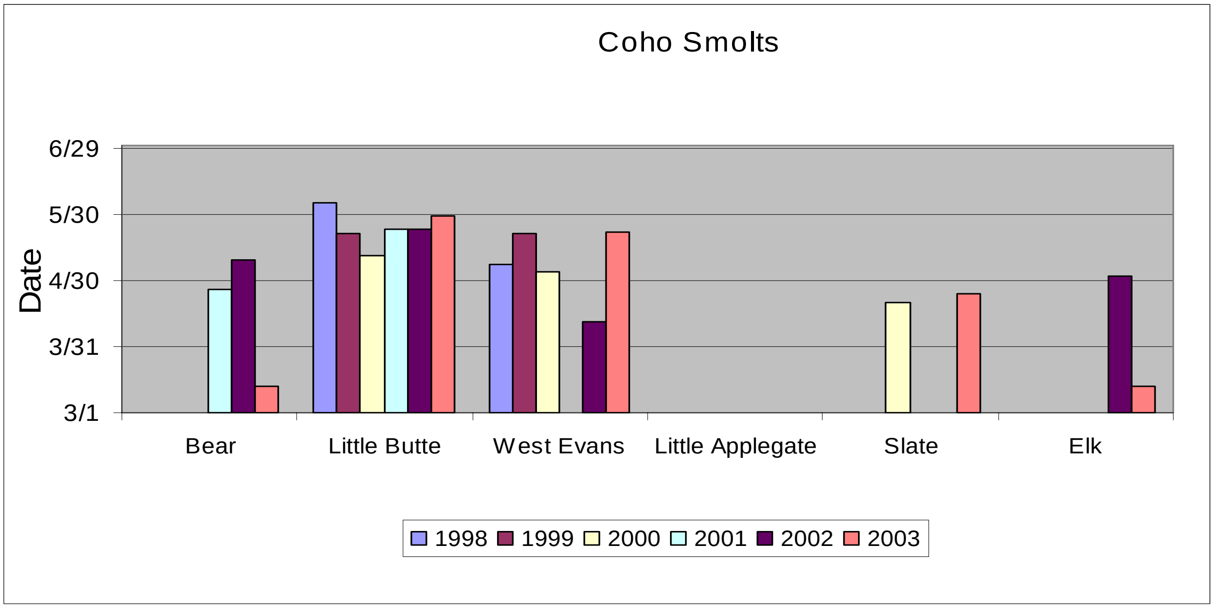

Figure 13. Date of peak week of migration of coho salmon smolts at six trap sites 1998-2003. (Taken from Figure 12, ODFW 2003).

Table 7. ODFW Coho Salmon Run Timing, at Gold Ray Dam 2004-2005. Information is Preliminary and Subject to Change

2 - Week Period	This Year # Fish To Date	# Fish To Date 10 - Yr. Avg.	# Fish To Date All - Yr. Avg.	Percent Of Run To Date 10 - Yr. Avg.	Percent Of Run To Date All - Yr. Avg.
9/1-15	2	3	1	0.0%	0.0%
9/16-30	42	34	10	0.2%	0.2%
10/1-15	481	327	108	1.8%	1.8%
10/16-31	4,263	3,339	1,248	18.5%	20.4%
11/1-15	12,691	10,374	3,685	57.5%	60.2%
11/16-30	18,405	15,581	5,373	86.4%	87.8%
12/1-15	20,787	17,528	5,965	97.2%	97.4%
12/16-31	21,575	17,993	6,104	99.7%	99.7%
1/1-15	21,697	18,037	6,121	100.0%	100.0%
1/16-31	21,702	18,042	6,123	100.0%	100.0%
TOTAL:	21,702				

Spring Chinook Salmon
Spring Chinook salmon adults pass GRD from early April through mid-August. Spring Chinook salmon peak passage occurs in mid- to late May (Figure 11).

Chinook salmon juveniles are known to rear in and migrate through the project area portion of the Rogue River. Almost all spring Chinook salmon in the Rogue migrate to sea in their first year of life. Migration of wild subyearling Chinook salmon was monitored at SRD for the 1975-1989 brood years, and peaked between June and August on average (ODFW 2000).

Steelhead
Winter steelhead adults pass GRD from early January through mid-May with the peak occurring in late March. Summer Steelhead adults pass GRD from early-June through mid-December. Summer steelhead peak passage occurs in mid-July and again in late October (Figure 11).

Steelhead are known to rear and migrate through the project area portion of the Rogue River. In the spring, these rearing steelhead juveniles and any juveniles that rear upstream from the action area must migrate through the action area to reach the ocean.

Data on migration timing of steelhead in tributary streams has been collected through the interagency Upper Rogue Smolt Trapping Project, conducted on six tributary streams since 1998 with the primary involvement of ODFW, BLM and the USFS. The peak migration of steelhead smolts has ranged from mid-April to mid-May in Bear Creek, Little Butte Creek and West Evans Creek (Figure 14). All three tributaries are located above SRD, while the Little Applegate River, Slate Creek and Elk Creek (a tributary to the Illinios River) are located downstream of SRD. A graph of the peak week of outmigration by tributary during the project was included in the 2003 report (Figure 15).

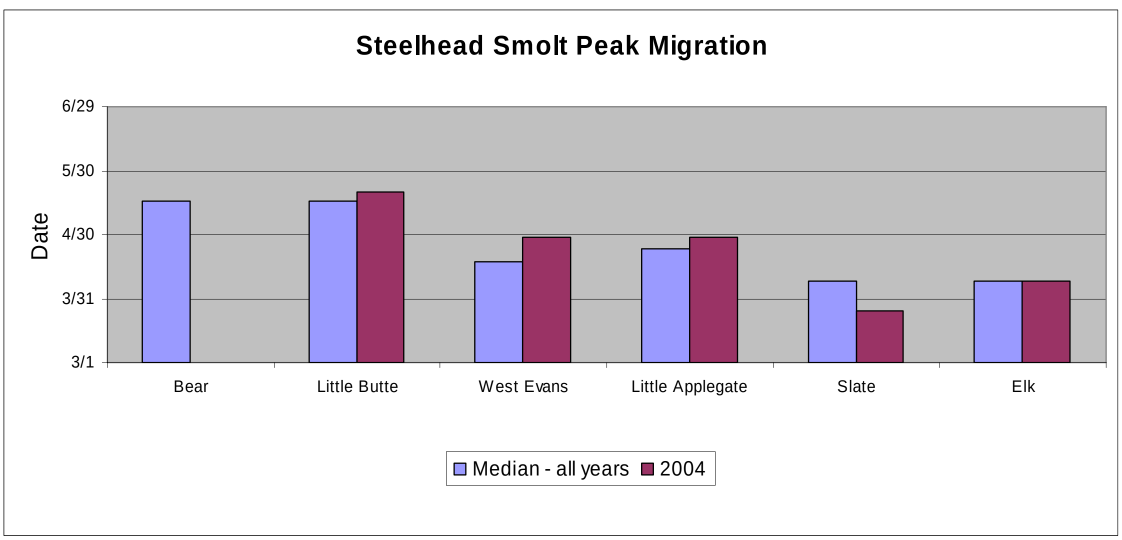

Figure 14. Date of peak week of migration of steelhead smolts at six trap sites. (Taken from Figure 14, ODFW 2004)

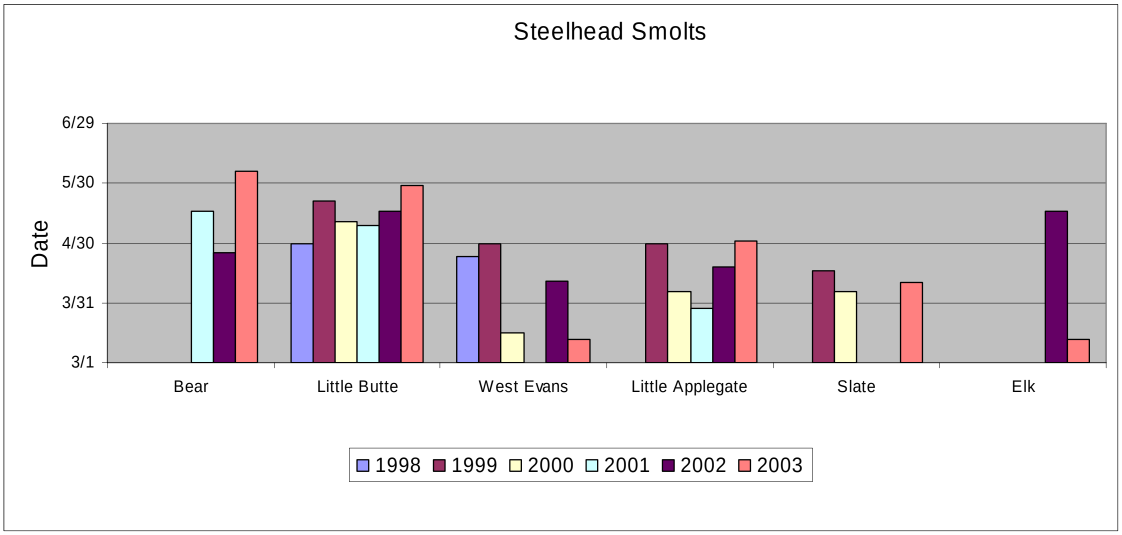

Figure 15. Date of peak week of migration of steelhead smolts at six trap sites 1998-2003. (Taken from Figure 13, ODFW 2003).

In summary, the timing of adult and juvenile fish migration also has a role in how anadromous fish are impacted at SRD. This is because different passage conditions exist at the structure at different seasons of the year (e.g., north ladder only operates during the irrigation season, flows vary by season, etc.); and the condition and size of fish varies by season and species, (e.g., spring Chinook salmon hold in the upper river 3 to 4 months prior to spawning after passing SRD, while many fall Chinook salmon are ripe by the time they pass SRD and may spawn soon afterwards). The best indicators of timing for fish at SRD are the count periods for adult fish upstream at GRD, and catches of juvenile fish in the downstream migrant trap at SRD. Table 8 presents a general summary of fish passage for juvenile and adult salmon and steelhead at SRD.

Table 8. General Timing of Fish Passage at Savage Rapids Dam[1]

ADULTS	
Species	Timing
Fall Chinook salmon	Aug. 16 – Nov. 30 (50 % through late Sept.)
Spring Chinook salmon	April 1 – Aug. 16 (50 % through middle June)
Coho salmon	Oct. 1 – Dec. 15 (50 % through middle Nov.)
Summer Steelhead	May 16 – Dec. 31 (50 % through middle Sept.)
Winter Steelhead	Jan. 1 – May 15 (50 % through middle March)
JUVENILES	
Chinook salmon	May – October
Coho salmon	April – June
Steelhead	March - September

A number of changes have occurred that have influenced the distribution of anadromous fish in the Rogue River basin, besides the obvious influence of Cole M. Rivers Hatchery

[1] Information for adults is from count periods at GRD, while data for juveniles is from the trap at SRD or from ODFW seining before the trap was operated.

and its operation. These changes have influenced the number of fish upstream of SRD, as well as the harvest rate of fish in the river and in the ocean. A general summary of some of these changes is listed in Table 9.

Table 9. General changes associated with operation of Lost Creek Dam as they affect Rogue River fisheries and numbers of fish subject to passage problems at GRD.

CHANGE	
1	Wild spring Chinook salmon production decreased and hatchery production increased.
2	Spring Chinook salmon wild fry abundance decreased in 1978-1984 but may have increased 1985-1993.
3	Earlier spring Chinook salmon fry emergence from gravel and reduced abundance influences faster growth in river and earlier ocean entry.
4	Spring Chinook salmon adults mature at earlier ages (2-4 years) and contribute to the fisheries at lower rates than older adults (5 years).
5	Relative abundance of fall Chinook salmon increases in the upper Rogue River.
6	Spawning distribution of spring Chinook salmon shifted downstream while fall Chinook salmon shifted upstream
7	Spring Chinook salmon are more valuable to the river fishery than fall Chinook salmon, while fall Chinook salmon contribute best to the ocean fishery.
8	Commercial harvest of Chinook salmon decreased because of lower fishing effort and a decrease in age at maturity for spring Chinook salmon.
9	Reduced prespawning mortality for Chinook salmon is strongly correlated with increased flow and lower temperatures from Lost Creek Dam.
10	Angler harvest in the river increased when prespawning mortality was decreased.
11	Winter peak flows are reduced with flood control operations and summer base flows are increased substantially in the Rogue River.
12	Returns of wild and hatchery summer steelhead have co-varied since 1976.

While Table 3 shows that the concerns about increased fish numbers at SRD has occurred, and Table 9 explains some of the likely reasons for these changes, other factors have also had an influence. Chinook salmon numbers have been increasing above SRD because of the shift of fall Chinook salmon spawning to areas further upstream and the operation of the hatchery (spring Chinook salmon releases), although, at the same time, wild Chinook salmon production has decreased by about 60 percent. Another factor contributing to the increased counts of Chinook salmon is reduced ocean harvest to protect Klamath River stocks of Chinook salmon. Rogue and Klamath River stocks are mixed in the ocean off northern California and southern Oregon and reduced harvest has contributed to the increased returns (ODFW 1989). Coho salmon increases are associated with increased releases from the hatchery (ODFW 1985), as the coho salmon run in the Rogue River upstream of GRD may now be predominately a hatchery run. Remnant runs of wild fish may still exist in Elk Creek and Big and Little Butte Creeks, but strong correlations exist between adult counts at GRD and returns to the hatchery. During the late 1980’s and early 1990’s, total steelhead numbers were reduced from long-term averages, with increases in hatchery fish and decreases in wild fish, probably related to concerns for habitat losses in tributaries as it effects wild fish production and poor ocean conditions for young steelhead (ODFW 1994).

Opponents to the dam removal have cited increased counts at GRD as evidence that at the least, fish losses at SRD are overstated, or at worst, losses do not really occur and runs are increasing upstream despite SRD. The resource agencies believe that most of the increases in run size upstream of SRD can be attributable to changes in the Rogue River associated with operation of the Lost Creek Dam Project (Table 9), and that there are still ample reasons to believe significant losses occur at SRD because of existing fish passage problems. A summary of the continued passage problems as they have been identified thus far is listed in Table 10. In early 1994, an ODFW fish passage expert visited the site and discussed the passage problems from first hand, one-time observation of conditions at SRD during that visit (ODFW 1994, Frank Young memo, see Appendix B of this report). It is important to note that very little evaluation of effectiveness has occurred for the passage measures that have been implemented, and in some cases (e.g., juvenile fish screens) the measures do not comply with existing fish passage criteria, or are not in use during extended periods because of breakdown or the generally poor condition of equipment and ongoing maintenance problems and/or practices. Separate photos of the north and south side areas of the dam show conditions of spill, false attraction, and generally poor passage conditions (Figure 4 and 5).

Another measure taken to address passage problems at SRD impacting coho salmon is the ongoing Habitat Conservation Plan (HCP), between NMFS and the GPID, under Section 10 or the Act. This HCP authorizes the take of up to 2,500 juvenile and 1,200 adult coho salmon per year by the continued operation of the Project. This authorization goes through November 2005, and an extension of the authorization through 2006 is a potential option.

The HCP provided take limitations during operation based on monitoring guidelines. During the first two days of operation, GPID will sample the trap at the traveling screen bypass every three hours, beginning no later than three hours following the initial start of irrigation diversion. GPID will immediately cease diversion activities for 72 hours if a cumulative total of 100 or more age 1+ juvenile coho salmon are observed in the trap at any time during a 24-hour period. A NMFS representative may be present during this period.

Through June 15 of each year, GPID will sample the trap at the traveling screen bypass every 12 hours during water diversion operations, and once daily until July 15. During this time, GPID will immediately cease diversion activities for 48 hours if 100 or more age 1+ juvenile coho salmon are counted in the trap at the traveling screen bypass during a 24 hour period. For purposes of these “trigger” calculations, five age 0+ fish will be considered to be the equivalent of one age 1+ fish.

In addition, in the event that excessive juvenile coho salmon mortalities result from trapping, subsampling at the traveling screen bypass by GPID will be permitted to reduce mortalities as long as NMFS is informed and involved in the subsampling strategy development. Any subsampling strategy must include measured sampling periods throughout the 24-hour period, be representative of the sampling period, and be frequent enough to reasonably minimize trapping mortalities.

Table 10. Summary of continuing fish passage problems at Savage Rapids Dam, Rogue River, Oregon

PROBLEMS	
1	Regulations of flows in the south ladder
2	Unfavorable entrance and exit conditions from the south ladder under all flows, i.e., ladder now exits through canal headworks; at high flows fish approach through channel behind ladder towards shore, and at low flows, fish may have to jump to enter some sections of ladder, etc.
3	Marginal use of the north ladder at all times during its operation because of poor attraction flows, steep gradient and small pools.
4	North ladder only operates during irrigation season.
5	Delays during drawdown of the reservoir (after irrigation season) because of dewatering of the south ladder or in the spring with installation of the stoplogs.
6	Increased turbidity during fall and spring flushing that occurs when crest is dewatered for removal or addition of stoplogs.
7	Impingement of juvenile fish on screens, or juveniles bypassing the screens with faulty seals or screen breakdown.
8	Increased trash and vegetation buildup because of flow regulation with Lost Creek Project or people dumping debris into Savage Rapids Reservoir.
9	Loss of juvenile fish passing over the dam and striking the sill or rocks below; increased spill during irrigation season with increased summer flows from Lost Creek Project.
10	Steelhead kelt mortality for the same reasons (#9 above).
11	Smolt losses to pressures at the sluce gates when at full pool.
12	Increased predation from Umpqua pikeminnow in areas immediately upstream and downstream of SRD.

The following additional monitoring actions are required of GPID as part of the HCP:

1. GPID will continue a net-based sampling program on one of the two canals flowing from the Tokay Canal/Evans Creek Lateral headworks to quantify numbers of fish which may be bypassing screens, with monitoring of the net done daily during each business day after water diversions begin at the North Turbine-Pump Intake through July 15: and,

2. GPID will continue to sample impingement using a washbasket for at least six daylight hours and at least six nighttime hours per week during facility operations.

Possible stranding of fish from swimming out of the fishways will be monitored daily if high water occurs, and fences placed along the fishways to prevent adult fish from jumping out of the ladder during migration will be monitored and maintained, and any stranded fish rescued and returned to the river.

In summary, increases in runs of anadromous fish upstream of SRD (as evidenced in counts at GRD) does not mean that passage problems do not exist, but that runs could have been even greater if the problems did not exist, or were minimized. Increased escapement of fish upstream of SRD, and an increased proportion of the Rogue River production coming from the upper basin, only means more fish are subject to poor passage conditions and the increased likelihood of fish losses. An example of this was the failure of the bottom seal on one of the gravity canal drum screens in September 1991 and the estimated 100,000 spring Chinook salmon smolts directed into the canal (ODFW 1991). Until a permanent solution to the passage problems is implemented, losses will continue and the full production potential of the Upper Rogue River basin will not be realized.

WILDLIFE

Habitats in the immediate vicinity of SRD include a narrow strip of riparian vegetation on both sides of the river, disturbed areas of grass, weeds, or exposed soils associated with parking, maintenance, or visitor uses, and the rive and reservoir pool upstream of the dam. The riparian vegetation consists of cottonwood, willow, alder, blackberries, nettle, and common understory grasses and forbs. The largest piece of this habitat occurs on the south shore just downstream of the South ladder and is less than two acres in size. Riparian vegetation on the river shore upstream of the dam has been mostly eliminated with private landowner or business practice and the desires to see the river and/or have access to it.

During the irrigation season (April through September) when the stoplogs are in place, the level of the river is increased by about 11 feet and a small reservoir is formed behind the dam. This creates a slack-water pool of about 110 surface acres that extends upriver for approximately 3.5 miles. This shoreline area is heavily occupied by private homes or businesses, many of which have small docks, boat ramps, steps or other access means to the water. Swimming, fishing, boating, jet skiing, and water skiing are common summertime activities. In the winter, the reservoir is evacuated as the stoplogs are removed and the pool becomes riverine, with mostly river conditions of gravel bars, cobble, sand and mud flats along the shore, except for a small pool located immediately behind the dam.

Wildlife use of these habitats is mostly by those species associated with water/riparian areas where human disturbance is high. Waterfowl species are the most common, with greatest numbers occurring during spring and fall migrations periods.

FUTURE WITH THE PROJECT

FISH

Removal of SRD would allow unimpeded movement of anadromous fish both upstream and downstream in the Rogue River, and eliminate fish losses that presently occur. Pumping facility intakes would be paced well into the river at sites with adequate depth and flow, and with screen that meet existing screen criteria, so it is anticipated there would be relatively little (if any) fish losses with the new pumping operations.

Although some current anadromous fish runs to the Rogue River are at depressed levels (ODFW 1992), operation of the Corps' Lost Creek Project and Cole Rivers hatchery has shifted a larger percentage of the basin's production upstream of SRD (especially fall Chinook salmon, summer steelhead, and coho salmon). Also, run sizes to the Rogue River vary as much as 10-fold, and the percent of total run component for each species/race varies by year (Table 3, Appendix A, page 1). Other changes that occur annually in terms of water year and conditions at SRD, operation of the irrigation system (GPID operations), hatchery practices and operation of the Lost Creek Project, also influence total numbers of fish at SRD and how they are impacted by passage conditions. Periodically since 1985 the resource agencies have discussed and recommended detailed biological studies to better understand and document the means and extent of losses at SRD, but these have never been accomplished.

The earlier prediction of losses (NMFS 1979, Service 1981) was determined by computing estimated losses that would occur for both adults moving upstream as well as for juveniles moving downstream, as a percent of the total number of fish passing the SRD, by species and race. Benefits were portrayed as increased numbers of adults returning to the Rogue River when the losses were eliminated or reduced, depending on the alternative, SRD removal and replacement with pumps would effectively eliminate all the losses. The earlier estimate was 22 percent of the total run size at SRD.

Because there have been no detailed biological studies, the resource agencies recommend that the 22 percent of total run size at SRD (as estimated by counts at GRD) can be used to depict a range of benefits for passage improvements for the present analysis. This range can be developed by looking at the high year, low year, last 10-year average, and an average for the 53-year period of counts (1942-1994) at GRD. This analysis shows that the benefits would range from 30,850 adults in the high year (1987); 4,508 adults in the low year (1959); 17,227 adults for the last 10-year average (1985-1994); and 11,640 adults for the entire 53-year period average. Breakdowns by species and race are presented in Table 11.

This analysis generates estimated benefits in a spreadsheet format taking into account the variation in mortality rate by species and lifestage. The analysis uses updated distribution abundance, both hatchery and wild stock, catch and escapement ratios, sport versus commercial catch, and other relevant information for each species. The range of mortalities were used based on other dams in the region with fish facilities and reasonable estimates by fish passage experts where studies have been conducted to document the mortality rates of these various fish passage facilities. This range of mortalities recognizes the variability in conditions that influence how fish are affected by passage conditions (beyond just the actual numbers of fish returning) and give a range of values within which an average, annual loss (impact) likely lies. The mortalities ranged from a low of five percent for steelhead and 10 percent for salmon, up to a high of 30 percent for all species, with the dam removal alternative. The dam retention alternative used low range mortalities of zero percent for both adults and juveniles (all species) and high range mortalities of three percent adults and five percent juveniles (all species).

The analysis looked at both escapement and harvest together, thus representing the total effect on production from the basin, and the full range of benefits with passage improvements. This is in contrast with the earlier analysis which looked as escapement only and calculated harvest benefits separately. Table 12 shows a summary of the range of benefits from the ODFW updated analysis in comparison with earlier analysis from the 1979-81 information. Based on new estimates of catch escapement ratios from the ODFW work (Table 12) the earlier escapement levels were used to generate existing production levels so that the estimate could be compared to these new numbers. The 26,700 spawning adults from the earlier work would represent a production level of 57,444 adults compared to the ranges of adults in the new ODFW analysis 20,865 to 93,541 for dam removal. The ODFW work has the advantage of using up-to-date information on the status and relevant life history requirements for Rogue River basin stocks of anadromous fish, and also shows that the earlier work is still a reasonable estimate of the potential benefits that would occur with passage improvements. Given the substantial number of anadromous fish passing upstream of SRD, and the very poor passage conditions that exist there now, even the lowest range of mortalities provides substantial benefits with improvements.

Using GRD counts for SRD passage adds a conservative factor to these benefits because of production that occurs in the mainstem Rogue River and tributaries (Evans Creek and other drainages) between these two structures. This is especially true for fall Chinook and coho salmon and steelhead. GRD counts are good estimates for SRD passage numbers for spring Chinook salmon.

The range of numbers shown in Table 11 are developed by using the same total percentage (22 %), with the same ratio for each species as its part of the total (i.e., 9,100 spring Chinook salmon out of 26,700 fish means spring Chinook salmon is 34 % of the total returns to SRD, as based on counts at GRD). However, another likely source of variation in fish benefits with passage improvements is the variation in rates of mortalities to adults and juveniles that would occur with different passage conditions. In other words, vary the 22 percent.

Table 11. Range of estimated benefits in increased adult anadromous fish returns to the Rogue River with removal of SRD based on counts at GRD.

SPECIES	First Analysis[2]	High Year (1987)	Low Year (1959)	Last 10-Yr Average (1985-94)	Since Lost Creek (1977-94)	Period Average (1942-94)
Spring Chinook	9,100	10,487	1,533	5,857	5,025	3,958
Fall Chinook	8,200	9,562	1,397	5,340	4,582	3,608
Coho	400	311	44	173	150	117
Summer Steelhead	4,400	4,935	721	2,756	2,364	1,862
Winter Steelhead	4,600	5,552	811	3,101	2,660	2.095
TOTAL	26,700	30,847	4,508	17,227	14,781	11,640

Table 12. Estimated range of benefits (increased production) from ODFW updated analysis compared to earlier analysis for SRD fish passage improvement alternatives.

SPECIES	NMFS 1979	USFWS 1981[3]			ODFW 1994 & 1995[4]		
	Escapement	Harvest	Dam Removal			Dam Retention	
			High	Med.	Low	High	Low
Spring Chinook	9,100	9,100	30,548	14,097	6,326	30,548	2,495
Fall Chinook	8,200	16,400	13,737	7,927	5,338	10,675	1,002
Coho	400	400	1,929	890	400	1,809	787
Summer Steelhead	4,400	2,728	25,697	10,402	4,665	24,697	1,072
Winter Steelhead	4,600	2,116	21,630	10,304	4,136	21,630	159
	26,700 +	30,744					
TOTALS	57,444		93,541	43,620	20,865	90,358	5,515

[2] From earlier analysis of benefits (NMFS 1979, Service 1981)
[3] Includes only the dam removal alternative, dam retention has 5% less benefits because of some passage problems that would continue with new facilities (Service 1990). Harvest levels are determined based on catch: escapement ratios (Table 13) to develop comparable production numbers to ODFW work.
[4] Each alternative has a range of benefits: High, Medium, or Low, based on different mortalities to adults and/or juveniles, and include both escapement and harvest to show the range in total increases in production (see Appendix C and D for spreadsheet analysis from ODFW 1994a & 1995b).

Table 13. Updated Economic Information for Conducting Benefit Analysis of Fish Passage Improvements at SRD.

SPECIES	Catch: Escapement[5]	% Commercial: Sport Harvest[6]	Average Weight[7]	Exvessel Price[8]	# Days Sport Harvest[9]
Spring Chinook	2:1	90:10	9.3 lbs.	$1.69	1.08
Fall Chinook	1:1	78:22	9.3 lbs.	$1.69	1.08
Coho[10]	1:1	66:34	5.3 lbs.	$1.25	1.08
Summer Steelhead (hatchery only-31%)	2:1	00:100			3.3[11]
Winter Steelhead (hatchery only-23%)	2:1	00:100			2.9[12]

Based on criticisms that the earlier analysis are not representative of current conditions for Rogue River anadromous salmonids, and to show the benefits based on a range in levels of mortalities to both juvenile and adult fish, the ODFW conducted a separate analysis of potential benefits with passage improvements at SRD (ODFW 1994a and 1995b). The details of this separate analysis are attached as Appendix C to this detailed report.

WILDLIFE

Only minor changes to wildlife would occur with removal of SRD. A 110-acre, 3.5-mile long seasonal reservoir (irrigation season) would be converted from a slack water pool to a free-flowing river. Some waterfowl species that use the pool area for foraging and resting would be displaced by wildlife associated with riverine (flowing) conditions. Dippers, mergansers, mallards, mink, raccoon, and numerous shorebirds and waders

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[5] From ODFW estimations of SRD impacts on salmon steelhead (ODFW 1995).
[6] Statewide average for eighteen-year period, 1971-1988 (Pacific Fisheries Management Council 1989)
[7] 1987 Statewide Average (ODFW 1989).
[8] Ten-year average for period 1978-1987 (ODFW 1989)
[9] Eight-year average for period 1981-1988 (Pacific Fisheries Management Council 1989).
[10] While there was no harvest of Rogue River coho salmon in the 1994 and 1995 seasons, it is assumed there would be a modest harvest rate in recovering populations based on passage improvements at SRD and implementation of other restoration efforts (watershed health initiatives, Northwest Forest Plan, etc.)
[11] Steelhead catch effort calculated from ODFW creel census information associated with Elk Creek Project (ODFW 1989). Information is applicable to hatchery population because wild fish are catch and release only.
[12] Same as 11

would use exposed shorelines, riffles or gravel/sand bars and flats that are now flooded during the irrigation season, i.e., when most of the shoreline is someone's back yard. Because the existing shoreline area is highly developed as private homes or businesses, and human disturbance would continue to be high with dam removal (river uses may shift from existing private use to increased public use for water-related activities, e.g., floating, rafting, boating, etc.), overall wildlife use of the project area would remain low. About two acres of riparian tree and shrub habitat in the area of the existing dam would be removed when the pumping facilities are installed.

DISCUSSION

BENEFITS OF DAM REMOVAL

The preferred federal action is to remove SRD and replace it with a pumping facility to provide water to the GPID, and finally resolve long-term fish passage problems that continue to exist at the dam. This action supports the decision of the Board of Directors of GPID as identified in its Water Management Improvement Study final report to the Oregon Water Resources Commission, dated March 8, 1994; and the action of the Water Resources Commission in issuing a permit for continued withdrawal of water at SRD by the GPID, pending removal of the dam within 5 years and replacement with pumps (October, 1994).

An alternative to the preferred plan includes leaving SRD in place and renovating all fish passage facilities and the pumping system. While fish benefits would be substantial with this plan, the earlier analysis of benefits estimated that losses of about 5 percent of adult passage at SRD would still occur. This difference may be low because some problems (predation in the pool end at the dam) would still remain, and the opportunity to restore fall Chinook salmon spawning in gravels in the impounded reach would not be realized. The ODFW analysis (Appendix C) provides a range of benefits for evaluating this alternative of SRD retention and passage improvements. The assumptions for the low range values are that the existing passage conditions at the dam cause low percentage losses to fish, and with improvements in fish passage, some low level of losses would likely continue, thus a small difference between the two. Conversely, the high range assumes an existing high level of losses, and no losses with the new passage facilities (unrealistic), and thus a large difference between the two. The straight-across assumption from the earlier report (Service 1990) of about five percent losses that would still occur are well with the range of values developed by the ODFW analysis.

Additionally, the dam retention plan would cost approximately $6.4 million more (in 1993 dollars), and still be subject to short-term but significant fish losses at any time when there may be a system failure with any of the new fish facilities. A similar situation happened in the fall of 1991 when the bottom seal on one of the gravity canal drum screens failed, and up to 100,000 spring Chinook salmon smolts were diverted into the canal. The ODFW estimated that of these, about 10,000 fish were lost.

Of even greater concern for the long term with dam retention is the ongoing urban development of the GPID service area and lands being converted to housing and placed on the Grants Pass City's water supply system. This means there may be a smaller and smaller patronage responsible for the Operation and Maintenance costs. This could be particularly difficult with the higher costs of the dam retention alternative and the need to maintain expensive new fish facilities and upkeep on an old, outdated dam. At any such time that the costs of doing business could not be met, if the GPID would cease to exist, then the facilities could become the public's responsibility. If this unfortunate scenario occurred in the future, under either alternative, then the preferred plan has the distinct advantage in that it has dealt with what would be the biggest liability, the dam. For these reasons, it is the recommendation of the resource agencies that dam removal is the only viable option at this time, and dam retention would not be preferred by the federal government.

To avoid further listings of salmon or steelhead species under the Act, it will be necessary to protect the diversity and genetic integrity of individual stocks of anadromous fish and insure connectivity between these stocks. This means recognizing the value of wild fish and the habitat it takes to produce these fish. This concept has formed the broad basis for several region-wide conservation efforts to restore fish populations to sustainable levels. Most notable in the region include the Northwest Forest Plan for ecosystem management of forests within the range of the northern spotted owl, and the Fish and Wildlife Program of the Columbia River basin under the Northwest Power Act.

A handbook for identification and prioritization of salmon restoration opportunities in Oregon identifies the need to focus on healthy ecosystems and relatively sound stocks of fish as the most important starting point (Pacific Rivers Council 1995). This system was developed by a working group that included fishery scientists, resource managers, fishing interests and conservation groups, and a test of the process was initiated in three broad western Oregon regions. A preliminary ranking from this effort identified the Lower Rogue River basin below GRD as one of the two areas with a "very high priority" for restoration. This area was targeted because it has several areas identified by the Northwest Forest Plan and American Fisheries Society for restoration work, and it has a history of relatively large, healthy, and/or diverse stocks of fish.

Under the Oregon Plan for Salmon and Watersheds (Oregon Plan) approximately $52 million was provided by the state legislature since 1997 to accomplish watershed restoration actions throughout Oregon (OWEB 1999, 2001, 2003, 2005). Federal agencies, including the Service, NMFS, Reclamation and U.S. Forest Service have provided another $100 million on activities supporting the Oregon Plan during the same time period (OWEB 1999, 2001, 2003, 2005). From 1995 through 2003, approximately $16 million was provided through the Oregon Plan and federal agencies for restoration activities in the Rogue River basin (OWEB 2005). Private sector voluntary funding during this time is estimated at more than $9 million (OWEB 2005). These contributions to restoration activities in the Rogue River basin have improved fish passage conditions at mainstem passage barriers, implemented water quality improvements, protected riparian and aquatic habitats in rapidly urbanizing areas and provided enhanced flow conditions in key anadromous salmonid habitat areas (OWEB 2005). Federal and state agency funding; coupled with private sector funds continue to be available to these restoration efforts and are all comparable in their recognition of the value of high quality habitat in sufficient amounts to produce sustainable population levels of anadromous fish as part of healthy functioning ecosystems (OWEB 2005).

Removal of SRD and the expected increase in anadromous fish to the Rogue River basin would strongly compliment habitat restoration efforts. Increased escapement would mean more fish to effectively utilize restored habitat. The 1970's analysis of benefits completed by NMFS and the Service estimated that approximately 45 percent of the spawning population of anadromous fish occurred upstream of SRD, ranging from 100 percent for spring Chinook salmon to 11 percent for fall Chinook salmon. Since operation of the Lost Creek project in 1977 it appears that, in general, the upper basin is producing a greater portion of the basin's total production, especially since the lower basin tributaries have extremely depressed runs (ODFW 1992). An increase in adult returns to the Rogue River of 22 percent of the runs as estimated by counts at GRD is a significant number of fish in any given year, ranging between 4,508 fish to 30,847 fish for the low and high years, and an average of 17,227 adults for the last 10 years of returns, 1985-1994 (Table 10). These fish would contribute significantly to increased production of wild fish in the basin, and support significant sport and commercial fisheries that occur in the ocean and in the river. For coho salmon and steelhead, these represent increases to stocks that are at depressed levels and have been listed, in the case of coho salmon, or have been proposed, in the case of steelhead, for listing under the Act.

The NMFS proposal to list the KMP steelhead as a threatened species was challenged by the ODFW as inappropriate for the status of these steelhead in Oregon waters (ODFW 1995). ODFW's evaluation of the NMFS proposal suggests that too much emphasis was placed on catch data, incorrect data were used in a model of natural return ratios, and in particular that Rogue River steelhead populations vary differently than other populations in the KMP. Trend analyses of overall wild steelhead production in the Rouge River basin did no show a significant change during the period 1976 through 1994, but various run components showed different responses. Wild winter steelhead were stable during this period and the early-run wild summer steelhead increased while a late-run component of the wild summer steelhead decreased. In 2001, NMFS found the listing of KMP steelhead was not warranted (NMFS 2001).

Regardless of the listing status of KMP steelhead, substantial numbers of steelhead would benefit from improved passage conditions at SRD. Of the 26,700 fish estimated from the earlier benefits analysis, 9,000 were steelhead (or 34 % of the total). Similar figures from the ODFW analysis for dam removal (Appendix D) are 8,801 steelhead (42 % of the total) for the low range estimate, and 47,328 steelhead (51 % of the total) for the high range estimate. The ODFW figures also include harvest so are larger than numbers that just consider escapement (spawning fish). ODFW estimates of wild fish as a percent of the total population for runs upstream of GRD are 33 to 77 percent for summer steelhead and 68 to 87 percent for winter steelhead. Accordingly, a substantial portion of the benefits will occur to wild fish, thus aiding the enhancement or recovery of these runs.

For purposes of economic analysis, benefits in increases adult returns were used to calculate dollar values based on catch escapement ratios for each species/race of fish and how they contribute to the fisheries. The total dollar values from the 1981 report (Service 1981) were based on figures developed by NMFS for the Columbia River. Later figures for the Rogue River (ODFW 1988) show a total value of $31.5 million annually (1993 dollars) based on a catch of 162,000 Chinook salmon (sport and commercial) and 95,000 steelhead. Of the estimated 375,000 anadromous fish produced, this would leave an escapement of 118,000, or and average value of $267 per escaping adult. This compares to the value of $236 per escaping adult when considering all species from the 1981 report.

In the 1990 letter, the Service provided an updated list of figures (Service 1990) that could be used for an economic analysis based on Rogue Basin data where it was available, or from state-wide averages otherwise. We believe that the 1995 information from the ODFW analysis (Appendix D—catch escapement ratios, etc.) is the most complete information and recommend it be used for economic analysis as shown in Table 12). It should be noted that the economic information in this form is very dynamic and subject to a great deal of change from year to year. For example, the overall dollar value is based on the value of an escaping adult and the contribution that production makes to future catch, when, in fact, catch has been extremely restricted to help increase escapement for runs that are depressed (in fact, all ocean coho salmon sport and commercial harvest in 1994 was prohibited with similar restrictions in 1995). The more important value of returning fish is the biological contribution they make to preservation of stocks and recognition of their diversity and genetic integrity.

Because of the substantial benefits to anadromous fish in the Rogue River basin with the preferred plan, and the strong connection between this action and habitat restoration projects being implemented on both public and private lands in the basin, the resource agencies recommended that the Reclamation seek to implement this plan on an accelerated basis—possibly seeking action through a Congressional add-on appropriation. It is further recommended that the costs of implementing this plan be considered a federal, non-reimbursable cost because benefits are almost exclusively for anadromous fish—species of high national interest, some stocks of which were at record low levels of escapement and have been placed on the Endangered Species List for protection (coho salmon). Efforts now to reverse declines could be the first major steps to recovery for some stocks.

REMOVAL OF GRAVEL /DEBRIS DEPOSIT NEAR NEW PUMPING FACILITY

Information gathered during recent underwater surveys of the project site has provided a better description of the composition of channel features. Once thought to be a deposit of sediment (sand, gravel and cobble) in the area immediately upstream of the new pumping facility intake, this deposit is now characterized as having a significant amount of concrete rubble, sheetpile and large metal fragments as well as naturally occurring sediment. The origin of this feature is now thought to be a waste site from previous dam construction/maintenance efforts, along with sediment deposited during high-water events and operation of the radial gates.

Removal of this deposit is necessitated by the need to provide appropriate flow conditions in front of the new pumping facility intake.

The resource agencies recommend the removal of this gravel/debris deposit. Removal should be conducted during the normal inwater work period (June 15 to August 31). Materials removed should be disposed of in an approved upland disposal site.

FISH PASSAGE AT SAVAGE RAPIDS DAM

How anadromous fish are affected by passage conditions at Savage Rapids dam is a function of several factors. These include number, size and condition of the fish at the dam; time of year and water conditions (high or low flows, spill, rate of pumping, radial gates open or closed, ladder operation); and effectiveness of the fish passage facilities to provide optimal passage conditions (good attraction flows, regulated and consistent flows through the ladders, appropriate screen velocities, etc.). Fish passage is greatly reduced during periods of time when the radial gates are open to perform work on the Savage Rapids Dam.

Pellisier and Kalin (2001) recommended the radial gates should be left open the minimum amount of time required to perform the needed work, then be closed to allow fish passage. The authors reported large numbers of salmonids used the south ladder after both ladders had been dry for several days in May. Based on this observation, it appeared to the authors that salmonids may be prevented from moving upstream while the radial gates are open to perform work on the dam.

The resource agencies recommend that the reservoir drawdown(s) phase be conducted in such a manner as to minimize the period of time the radial gates remain open and the south fish ladder is out of operation.

If the inwater work begins on June 16, per Reclamation's proposal, the natural resource agencies reiterate the recommendation that Reclamation should take actions to ensure the time period the radial gates are open will be minimized. Actions to ensure meeting this timeframe could include extra work shifts, longer work days. Additionally, the general construction schedule must be truncated to ensure the scheduling dam removal activities to allow for optimal upstream fish passage before October 15 is considered a priority by the resource agencies.

IN-WATER WORK

Effects from in-water work are generally avoided and minimized through use of in-water work isolation strategies that often involve capture and release of trapped fish and other aquatic vertebrates. Although the most lethal biological effects of actions on salmon and steelhead will likely be caused by the isolation of in-water areas, lethal and sublethal effects would be greater than without isolation. In-water work area isolation is itself a measure intended to reduce the adverse effects of erosion and runoff on the population. Any individual fish present in the work isolation area should be captured and released. Capturing and handling fish causes them stress though they typically recover fairly rapidly from the process and therefore the overall effects of the procedure are generally short-lived (NMFS 2002). The primary contributing factors to stress and death from handling are differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18°C (64°F) or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, if the traps are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis.

Besides actions listed above, additional actions to avoid or minimize the adverse effects of in-water work include:

- Completing work below ordinary high water during preferred in-water work windows, when the most vulnerable life stages of fish are least likely to be present in the action area.
- Provide fish passage for any adult or juvenile salmonid species that may be present in the project area during construction.
- The preparation of a Work Area Isolation Plan for all work below ordinary high water that requires flow diversion. The Plan should describe the sequence and schedule for de-watering and re-watering activities, a plan view of all isolation elements, and a list of equipment and materials that will be used to provide back-up for key plan functions (*e.g.* an operational, properly-sized backup pumps and/or generators).
- Any water intakes used for the project – including pumps used to dewater the work isolation area – will have a fish screen installed, operated and maintained according to NMFS' fish screen criteria.

<u>IN-WATER WORK PERIOD</u>

Based on the best available information regarding fish presence within the project area, the Oregon Guidelines for timing of in-water work to protect fish and wildlife resources should be used to schedule activities. The guidelines are to assist in minimizing potential impacts to important fish, wildlife and habitat resources. The guidelines are based on ODFW district fish biologists' recommendations. Primary considerations are given to important fish species including anadromous and other game fish and threatened, endangered, or sensitive species. Time periods are established to avoid the vulnerable life stages of these fish including migration, spawning and rearing.

These guidelines provide a way of planning in-water work during periods of time that would have the least impact on important fish, wildlife, and habitat resources. There are some circumstances where it may be appropriate to perform in-water work outside of the preferred work period indicated in the guidelines. ODFW, on a project by project basis, may consider variations in climate, location, and category of work that would allow more specific in-water work timing recommendations. These more specific timing recommendations can be made by the appropriate ODFW district office through the established planning and regulatory processes.

The standard in-water work window (June 15-August 31) is appropriate for some of the activities related to the Project, such as the construction of the new pump facility, and removal of the gravel/debris deposit in front of the new pump facility intake structure. This work window will reduce impacts to the majority of the juvenile and adult migrants.

However, the construction schedule proposed by Reclamation for dam removal activities in 2008 presents a special circumstance that prompts consideration of work outside the standard inwater work period. This is due to the relative risk to migrating fish, such as the upstream migration of adult spring Chinook salmon. The timing of the downstream migration of coho and Chinook salmon and steelhead juveniles in the spring, as well as the upstream migration of adult coho salmon in the fall must also be considered.

Based on Reclamation’s proposed construction schedule for 2008, approximately 85 percent of the adult coho salmon could experience a delay in passing Savage Rapids Dam if passage conditions are not optimal after October 15 (Figure 11 and Table 7). Impacting this portion of the adult coho salmon run returning to the upper Rogue River basin would have severe consequences in terms of recovery for coho salmon in the basin and for the entire SONC coho salmon ESU.

Scheduling dam removal activities to allow for optimal upstream fish passage before October 15 is considered a priority by the resource agencies.

<u>USE OF CONCRETE RUBBLE</u>

During the original 1920's construction of the dam, a diversion channel was cut on the left side so that the right side of the dam could be constructed. Dam bays 10 and 11 span across this diversion channel. During the 1950's, bays 10 and 11 were removed, the diversion channel was widened and deepened both upstream and downstream of the dam, and the two radial gates were installed in bays 10 and 11.

Based on discussions with Reclamation (Susan Broderick, pers. comm. 2005), there are two issues with the diversion channel once the dam has been removed and the new pumping facility is operational: 1) Water flowing from upstream to downstream through the diversion channel and back into the river creates an eddy in front of the new pumping facility intake, which disrupts the required sweeping flow velocities in front of the intakes; and, 2) water flowing in the river backs into the downstream portion of the diversion channel disrupting the sweeping velocities in front of the new pumping facility intake.

Reclamation is currently considering allowing the contractor the option of: 1) disposing of concrete rubble from dam demolition in the radial gate channel (diversion channel) both upstream and downstream of the dam axis, or 2) transporting the concrete rubble to an approved upland disposal site. If the contractor chooses to use the concrete rubble to fill the existing diversion channel, the contractor would be required to cap the rubble with "dental" concrete to assure the rubble stays in place during future flood flows. The placement of concrete rubble in the diversion would be conducted in the "dry".

Salvaged concrete rubble would contain reinforcing material, and concrete dust. The introduction of concrete rubble into the diversion channel will pose threats to aquatic life by the presence of concrete dust in the water. The rubble could also create hazards to recreation activities such as boating.

Concrete rubble could be used if it is processed (reinforced metal removed and washed to remove concrete dust and debris) before placement in the diversion channel. To accomplish this task, the concrete debris from the north side would have to be transported approximately 10 miles, stockpiled and processed, then transported back to the site and placed in the diversion channel. The stockpiling of the material is necessary because the diversion channel would be needed to draw down the reservoir, remove sheet piles, and excavate the pilot channel before moving the river to the north side.

The concrete rubble must also be secured in a way to ensure it does not dislodge from the location and become a hazard to water related activities downstream. It may be possible to "cap" or otherwise contain the concrete rubble through use of a "dental concrete" seal. Construction of the concrete seal would need to meet state and federal guidelines for construction of concrete structures within the active channel.

At this time, based on the available information, the resource agencies can not support the use of the concrete rubble as "fill" in the diversion channel. The concrete rubble and associated debris from the dam removal phase of this project should be disposed of in an approved upland disposal area.

SOUTH FISH LADDER OPENING

The opening in the south fish ladder is designed to operate during higher flow conditions or when there is a need to direct water into the pool next to the opening from over the dam crest (Figure 10). If kept in place, the opening would allow water to enter the proposed construction site of the pumping facility.

The "high water" opening in the south fish ladder was designed to provide passage for fish and to reduce the possibility of adult fish stranding or being trapped during high flow events. This feature has had mixed success in the past and due to maintenance and other issues, the feature is not an essential part of the fish ladder operation. Given the proposed schedule and course of action, this opening would be blocked in 2006. The south fish ladder will no longer be needed after the fall of 2008.

The blockage of this opening is supported by the resource agencies.

RECOMMENDATIONS

Based on the information presented here, and in the 1995 Report, it is the recommendation of the resource agencies that Reclamation continue to implement the recommendations presented in the 1995 Report:

1. The Bureau of Reclamation seek Congressional authorization to remove Salvage Rapids Dam and replace it with pumping facilities to permanently resolve long standing fish passage problems at the dam;
2. Implementation of these measures be sought on an accelerated time frame to expedite restoration efforts for declining stocks of anadromous fish in the Rogue River basin;
3. Funding for this effort be a non-reimbursable federal cost because of the substantial benefits to anadromous fish; and
4. The construction schedule for dam removal be coordinated closely with the Service, ODFW and NMFS to coordinate the specifics of in-water work schedules and activities with fishery concerns.

In addition, we provide the following specific recommendations in support of recommendation #4:

1) Reclamation implement the following construction schedule for dam removal:

    (a) Reservoir drawdown should occur in April through the use of the existing radial gates. Based on information from GPID, reservoir drawdown should take three days (April 7-10). The Reservoir should remain drawn down up to three weeks to expedite dam removal activities on the north side of the dam (April 7 – April 28). Every measure should be taken to minimize this drawdown period. Actions to ensure meeting this timeframe could include extra work shifts, longer work days.

        1. Construct upstream access road and cofferdam on the north side of the dam in the "dry".
        2. The downstream cofferdam on the north side of the dam will be constructed in the "wet".

    (b) Radial gates should close on or before April 29 to refill reservoir to facilitate fish passage through lower portion of south fish ladder. Reclamation should take actions to ensure the time period the radial gates are open will be minimized. Actions to ensure meeting this timeframe could include extra work shifts, longer work days.

    (c) From May 1 to September 7 (18 weeks) the following constructions should occur behind the cofferdams:

1. Excavation of reservoir sediments immediately upstream of the dam; and,
2. Removal of north side of dam (Bays 1 through 7).

(d) Lower reservoir for up to three weeks. September 8 to September 28, 2008.
1. Remove sheet piles from upstream and downstream cofferdams and excavate pilot channel through upstream and downstream cofferdams.

If the inwater work begins on June 16th per Reclamation's original proposal, the natural resource agencies reiterate the recommendation that Reclamation should take actions to ensure the time period the radial gates are open will be minimized. Actions to ensure meeting this timeframe could include extra work shifts, longer work days. Additionally, the general construction schedule must be truncated to ensure scheduling dam removal activities to allow for optimal upstream fish passage before October 15. Providing fish passage conditions on or before October 15 is considered a priority by the resource agencies.

In response to the natural resource agencies' recommendation regarding the proposed construction schedule, Reclamation has expressed interest in finishing work on the south side in the same year as the north side (2008), instead of undertaking removal of the south side of the dam in 2009. This proposal offers both cost savings and a potential reduction in the length of work-related impacts to the environment. Reclamation has proposed the following:

(e) Build access road and cofferdam on south side of dam from September 29 to October 13, 2008.

(f) Dam removal is estimated to take up to 7 weeks to complete (October 14 through December 2008).
1. Removal of south side of dam (bays 8 through 11).

(g) Remove sheetpiles and upper portion of cofferdam on south side of dam from December 2 to December 9, 2008. The winter floods should remove the remaining portion of the cofferdam.

The natural resource agencies best recommendation on this proposal is that the construction of the access road and coffer dam be accomplished as early as possible to avoid low-flow sediment impacts on spawning fall Chinook salmon. Completion of the access road and coffer dam before October 1 is preferred, with a concomitant shortening of remainder of the construction schedule.

2) Reclamation implement the following fish capture and release procedures:

a) Capture and release. Before and intermittently during isolation of an in-water work area, fish trapped in the area must be captured using a trap, seine, electrofishing, or other methods as are prudent to minimize risk of injury, then released at a safe release site.

1. Do not use electrofishing if water temperatures exceed 18^{o}C, or are expected to rise above 18^{o}C, unless no other method of capture is available.
2. If electrofishing equipment is used to capture fish, comply with NMFS' electrofishing guidelines.[13]
3. Handle coho salmon with extreme care, keeping fish in water to the maximum extent possible during seining and transfer procedures to prevent the added stress of out-of-water handling.
4. Ensure water quality conditions are adequate in buckets or tanks used to transport fish by providing circulation of clean, cold water, using aerators to provide dissolved oxygen, and minimizing holding times.
5. Release fish into a safe release site as quickly as possible, and as near as possible to capture sites.
6. Do not transfer coho salmon to anyone except NMFS personnel, unless otherwise approved in writing by NMFS. Requests for approval should be provided two months prior to implementation.
7. Obtain all other Federal, state, and local permits necessary to conduct the capture and release activity.
8. Allow NMFS or its designated representative to accompany the capture team during the capture and release activity, and to inspect the team's capture and release records and facilities.
9. Submit a Salvage Report (Appendix E) to NMFS within 10 calendar days of completion of the salvage operation.

3) Concrete rubble from the dam removal activities should not be used to fill in the existing diversion channel upstream and downstream of the dam axis. Concrete rubble from the dam removal activities should be disposed of in an approved upland disposal site.

4) Untreated stoplogs should be utilized to block the high water opening in the south fish ladder until feature is permanently removed.

[13] National Marine Fisheries Service Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act (June 2000) (http://www.nwr.noaa.gov/1salmon/salmesa/4ddocs/final4d/electro2000.pdf).

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Appendix A. Fish Passage Information at Gold Ray Dam 1942-2004, and Coho Salmon Run Size Estimates at Huntley Park (RM 6)

Appendix B. Memoranda from Frank Young to Stephanie Burchfield, dated July 15, 1994 and February 9, 1995.

Appendix C. Estimation of benefits for Savage Rapids Dam retention and improvement option, spreadsheet analysis conducted by the ODFW, 1995.

Appendix D. Estimation of benefits for Savage Rapids Dam removal option, spreadsheet analysis conducted by the ODFW, 1994.

Appendix E. Salvage Reporting Form

Appendix F. Letters of concurrence from NOAA-Fisheries and Oregon Department of Fish and Wildlife

Appendix A. Fish Passage Information at Gold Ray Dam 1942-2004, and Coho Salmon Run Size Estimates at Huntley Park (RM 6).

Estimated number of salmon and steelhead migrating over Gold Ray Dam, Rogue River

Return year	Spring chinook salmon	Fall chinook salmon	Coho salmon	Summer steelhead	Winter steelhead
1942	41,779	1,670	4,608	7,387	–
1943	36,136	1,611	3,290	5,048	15,314
1944	30,632	1,223	3,230	5,530	13,380
1945	31,896	1,841	1,007	7,302	16,083
1946	28,374	1,691	3,840	4,448	8,729
1947	33,637	1,176	8,340	3,221	9,853
1948	26,679	757	1,764	2,133	8,605
1949	18,810	1,233	9,440	3,618	8,052
1950	15,530	1,204	2,007	4,583	8,684
1951	19,443	1,480	2,738	3,262	5,744
1952	15,868	2,558	320	4,200	10,848
1953	31,465	2,083	1,453	3,831	10,945
1954	24,704	955	2,138	2,222	7,228
1955	15,714	838	480	1,703	6,238
1956	28,068	1,884	421	2,753	6,775
1957	17,710	1,060	1,075	1,323	4,508
1958	15,016	700	732	1,283	3,855
1959	13,972	735	371	865	4,550
1960	24,374	1,843	1,851	2,034	6,901
1961	31,775	1,260	232	2,408	6,968
1962	31,395	1,365	457	3,603	9,901
1963	40,567	960	3,831	1,508	9,024
1964	37,327	1,137	168	778	6,431
1965	47,844	1,778	462	2,144	7,310
1966	31,422	1,166	178	2,092	12,463
1967	14,893	1,800	89	1,637	5,150
1968	19,469	912	149	893	7,236
1969	59,043	2,190	530	7,768	6,559
1970	45,101	3,068	160	8,088	13,789
1971	28,473	2,407	181	4,909	8,442
1972	30,768	2,758	165	3,559	16,826
1973	35,276	3,818	193	5,236	9,568
1974	17,008	2,309	146	7,858	7,108
1975	21,483	2,312	154	8,338	10,367
1976	21,570	2,648	44	3,529	6,048
1977	16,403	5,181	522	11,352	4,724
1978	47,221	5,878	798	4,977	7,667
1979	38,207	3,083	1,744	14,867	12,767
1980	36,932	2,908	5,617	7,773	13,371
1981	17,213	4,787	6,725	11,929	8,197
1982	29,842	4,595	670	13,654	6,337
1983	12,511	3,839	1,493	7,681	9,728
1984	12,690	3,184	3,238	7,397	9,486
1985	40,545	8,455	1,170	7,611	10,462
1986	89,522	14,239	4,072	14,598	16,664
1987	81,581	10,699	5,395	24,855	17,587
1988	82,591	11,497	6,852	19,283	15,018
1989	60,332	8,903	1,401	12,411	14,590
1990	24,588	3,650	697	5,959	10,487
1991	12,350	3,205	2,562	4,575	4,547
1992	5,801	8,797	4,006	3,507	4,134
1993	26,103	6,711	3,486	10,595	6,479
1994	14,078	11,530	10,699	11,085	6,581
1995	61,951	14,366	13,018	13,884	12,434
1996	36,621	11,385	13,599	11,680	9,168
1997	41,794	4,857	15,790	7,538	14,957
1998	15,957	5,332	6,044	6,058	5,029
1999	20,981	3,540	7,722	4,785	8,487
2000	30,288	9,692	28,791	8,734	8,807
2001*	**33,273**	**13,606**	**32,992**	**16,114**	**8,944**
2002*	**47,781**	**19,823**	**34,154**	**29,296**	**22,287**
2003*	**41,841**	**24,857**	**17,179**	**20,287**	**24,850**
2004*	**38,243**	**15,007**	**21,702**	**13,608**	**21,889**
10 YR AVE.	36,971	11,916	18,042	12,748	13,596
AVE. ALL YRS	32,104	4,583	4,397	7,102	9,987

***PRELIMINARY, SUBJECT TO REVISION**
Revised: 2/8/2005

COUNT PERIODS

SPRING CHINOOK SALMON	- March 1	to August 15
FALL CHINOOK SALMON	- August 16	to January 15
COHO SALMON	- September 15	to January 30
SUMMER STEELHEAD	- May 15	to December 31
WINTER STEELHEAD	- January 1	to May 15

SPRING CHINOOK SALMON
GOLD RAY DAM

Year	# Wild	%wild	# Hatchery	%hatch	Total	Jacks < 20 in	Jacks < 24 in	Adults >= 24 in
1942	41,779	100		0	41,779	6,220		
1943	36,136	100		0	36,136	4,535		
1944	30,632	100		0	30,632	3,746		
1945	31,996	100		0	31,996	5,270		
1946	28,374	100		0	28,374	4,620		
1947	33,637	100		0	33,637	3,074		
1948	26,979	100		0	26,979	2,923		
1949	18,810	100		0	18,810	1,808		
1950	15,530	100		0	15,530	2,717		
1951	19,443	100		0	19,443	4,858		
1952	15,888	100		0	15,888	3,794		
1953	31,465	100		0	31,465	4,233		
1954	24,704	100		0	24,704	5,208		
1955	15,714	100		0	15,714	2,806		
1956	28,068	100		0	28,068	3,912		
1957	17,710	100		0	17,710	3,032		
1958	15,016	100		0	15,016	1,930		
1959	13,972	100		0	13,972	2,618		
1960	24,374	100		0	24,374	5,460		
1961	31,775	100		0	31,775	5,370		
1962	31,395	100		0	31,395	5,306		
1963	40,567	100		0	40,567	6,937		
1964	37,327	100		0	37,327	6,241		
1965	47,644	100		0	47,644	8,140		
1966	31,422	100		0	31,422	3,454		
1967	14,693	100		0	14,693	2,447		
1968	19,469	100		0	19,469	7,530		
1969	59,043	100		0	59,043	6,732		
1970	45,101	100		0	45,101	7,389		
1971	28,339	96	1,134	4	29,473	6,113		
1972	29,962	97	826	3	30,788	5,657		
1973	34,691	98	585	2	35,276	4,978		
1974	16,513	97	493	3	17,006	3,528		
1975	20,442	95	1,041	5	21,483	4,564		
1976	20,375	94	1,195	6	21,570	6,867		
1977	14,884	91	1,519	9	16,403	3,031		
1978	40,211	85	7,010	15	47,221	9,573	11,331	35,890
1979	29,278	77	8,929	23	38,207	2,469	5,762	32,445
1980	24,191	66	12,741	34	36,932	318	8,023	28,909
1981	12,841	75	4,372	25	17,213	1,536	3,005	14,208
1982	23,205	77	6,737	23	29,942	8,296	10,144	19,798
1983	9,846	79	2,665	21	12,511	2,946	4,653	7,858
1984	8,413	66	4,277	34	12,690	2,719	3,814	8,876
1985	27,814	69	12,731	31	40,545	-	15,008	25,537
1986	40,374	45	49,148	55	89,522	12,297	30,073	59,449
1987	37,446	46	44,135	54	81,581	3,875	16,229	65,352
1988	38,818	47	43,773	53	82,591	2,096	18,367	64,224
1989	7,903	13	52,429	87	60,332	678	6,550	53,782
1990	18,048	73	6,541	27	24,589	395	3,050	21,539
1991	9,337	76	3,013	24	12,350	213	2,370	9,980
1992	2,228	38	3,573	62	5,801	-	1,293	4,508
1993	12,634	48	13,469	52	26,103	2,696	6,756	19,347
1994	3,603	26	10,473	74	14,076	547	2,648	11,428
1995	20,726	25	61,225	75	81,951	1,217	6,172	75,779
1996	10,307	28	26,314	72	36,621	377	3,425	33,196
1997	9,599	23	32,195	77	41,794	551	2,814	38,980
1998	3,684	23	12,273	77	15,957	696	2,834	13,123
1999	5,952	28	15,029	72	20,981	608	1,871	19,110
2000	3,443	11	26,822	89	30,265	548	3,077	27,188
2001*	**9,340**	**28**	**23,933**	**72**	**33,273**	**861**	**2,287**	**30,986**
2002*	**6,989**	**15**	**40,792**	**85**	**47,781**	**1,996**	**3,197**	**44,584**
2003*	**19,270**	**46**	**22,571**	**54**	**41,841**	**1,859**	**2,994**	**38,847**
2004*	**13,254**	**34**	**25,989**	**66**	**39,243**	**2,489**	**3,806**	**35,437**
10 YR AVE.	10,256	26	28,714	74	38,971	1,120	3,248	35,723
AVE. ALL YRS	22,899	77	17,057	23	32,104	3,752	6,724	31,124

* PRELIMINARY, SUBJECT TO REVISION
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FALL CHINOOK SALMON
GOLD RAY DAM

Year	# Wild	%wild	# Hatchery	%hatch	Total	Jacks < 20 in	Jacks < 24 in
1942	1,670	100		0	1,670	537	
1943	1,611	100		0	1,611	678	
1944	1,223	100		0	1,223	437	
1945	1,641	100		0	1,641	732	
1946	1,691	100		0	1,691	348	
1947	1,176	100		0	1,176	198	
1948	757	100		0	757	63	
1949	1,233	100		0	1,233	327	
1950	1,204	100		0	1,204	265	
1951	1,489	100		0	1,489	458	
1952	2,558	100		0	2,558	481	
1953	2,083	100		0	2,083	397	
1954	955	100		0	955	451	
1955	836	100		0	836	120	
1956	1,884	100		0	1,884	195	
1957	1,060	100		0	1,060	144	
1958	700	100		0	700	136	
1959	735	100		0	735	318	
1960	1,843	100		0	1,843	806	
1961	1,260	100		0	1,260	340	
1962	1,265	100		0	1,265	304	
1963	960	100		0	960	324	
1964	1,137	100		0	1,137	108	
1965	1,776	100		0	1,776	609	
1966	1,166	100		0	1,166	98	
1967	1,800	100		0	1,800	977	
1968	912	100		0	912	149	
1969	2,190	100		0	2,190	790	
1970	3,068	100		0	3,068	1,239	
1971	2,407	100		0	2,407	855	
1972	2,756	100		0	2,756	600	
1973	3,816	100		0	3,816	1,212	
1974	2,309	100		0	2,309	664	
1975	2,312	100		0	2,312	467	
1976	2,648	100		0	2,648	1,622	
1977	5,181	100		0	5,181	3,181	
1978	5,878	100		0	5,878	2,043	2,331
1979	3,093	100		0	3,093	291	569
1980	2,786	96	120	4	2,906	745	881
1981	4,583	96	184	4	4,767	844	1,449
1982	4,403	96	192	4	4,595	2,157	2,497
1983	3,747	98	92	2	3,839	1,118	1,908
1984	3,113	98	71	2	3,184	581	938
1985	7,335	87	1,120	13	8,455	–	3,151
1986	12,354	87	1,885	13	14,239	3,422	7,602
1987	9,820	92	879	8	10,699	485	3,103
1988	10,965	95	532	5	11,497	306	2,167
1989	6,540	95	363	5	6,903	217	1,469
1990	3,601	99	49	1	3,650	66	797
1991	3,042	95	163	5	3,205	148	718
1992	6,647	98	150	2	6,797	–	3,256
1993	6,605	98	106	2	6,711	1,576	2,928
1994	11,409	99	121	1	11,530	2,637	3,909
1995	14,105	98	261	2	14,366	1,163	2,772
1996	11,220	99	165	1	11,385	1,598	2,499
1997	4,780	98	77	2	4,857	351	685
1998	5,264	99	68	1	5,332	389	1,472
1999	3,499	99	41	1	3,540	457	928
2000	9,861	100	31	0	9,892	417	1,419
2001*	**13,351**	**98**	**255**	**2**	**13,606**	**1,329**	**2,646**
2002*	**18,900**	**95**	**923**	**5**	**19,823**	**1,960**	**4,535**
2003*	**24,088**	**97**	**769**	**3**	**24,857**	**2,295**	**3,409**
2004*	**14,541**	**97**	**466**	**3**	**15,007**	**2,056**	**2,709**
10 YR AVE.	11,961	98	306	2	12,267	1,204	2,307
AVE. ALL YRS	4,585	99	363	1	4,729	809	2,324

*** PRELIMINARY, SUBJECT TO REVISION**

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Note: Hatchery fish estimates are for marked fish only and are not expanded to account for unn

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COHO SALMON
GOLD RAY DAM

Year	# Wild	%wild	# Hatchery	%	Total	Jacks < 20 in	Hatchery Jacks < 20 in
1942	4,608	100		0	4,608	217	
1943	3,290	100		0	3,290	201	
1944	3,230	100		0	3,230	336	
1945	1,907	100		0	1,907	84	
1946	3,840	100		0	3,840	211	
1947	5,340	100		0	5,340	166	
1948	1,764	100		0	1,764	85	
1949	9,440	100		0	9,440	406	
1950	2,007	100		0	2,007	237	
1951	2,738	100		0	2,738	230	
1952	320	100		0	320	7	
1953	1,453	100		0	1,453	134	
1954	2,138	100		0	2,138	231	
1955	480	100		0	480	46	
1956	421	100		0	421	23	
1957	1,075	100		0	1,075	77	
1958	732	100		0	732	84	
1959	371	100		0	371	18	
1960	1,851	100		0	1,851	94	
1961	232	100		0	232	2	
1962	457	100		0	457	0	
1963	3,831	100		0	3,831	318	
1964	168	100		0	168	0	
1965	482	100		0	482	12	
1966	178	100		0	178	0	
1967	89	100		0	89	0	
1968	149	100		0	149	0	
1969	530	100		0	530	0	
1970	160	100		0	160	65	
1971	181	100		0	181	0	
1972	185	100		0	185	0	
1973	193	100		0	193	0	
1974	146	100		0	146	0	
1975	154	100		0	154	3	
1976	44	100		0	44	17	
1977	12	2	510	98	522	15	
1978	244	32	512	68	756	118	
1979	201	12	1,543	89	1,744	1,555	
1980	1,629	29	3,988	71	5,617	2,631	
1981	2,683	40	4,042	60	6,725	577	
1982	597	89	73	11	670	475	
1983	796	53	697	47	1,493	748	
1984	2,139	66	1,097	34	3,236	469	
1985	459	39	711	61	1,170	348	
1986	1,474	36	2,598	64	4,072	647	
1987	1,527	28	3,868	72	5,395	960	
1988	3,558	52	3,324	48	6,882	643	
1989	268	19	1,133	81	1,401	141	
1990	212	30	485	70	697	62	
1991	195	8	2,367	92	2,562	253	
1992	0	0	4,006	100	4,006	920	
1993	756	22	2,730	78	3,486	1,698	
1994	3,265	31	7,434	69	10,699	1,525	1,077
1995	3,345	25	10,173	75	13,518	1,404	832
1996	2,554	19	11,045	81	13,599	2,055	1,228
1997	4,566	29	11,184	71	15,750	1,152	694
1998	1,310	22	4,734	78	6,044	1,284	1,034
1999	1,417	18	6,305	82	7,722	1,282	956
2000	15,652	54	13,139	46	28,791	6,332	3,652
2001*	**12,717**	**39**	**20,245**	**61**	**32,962**	**4,813**	**2,735**
2002*	**11,512**	**34**	**22,642**	**66**	**34,154**	**7,525**	**4,939**
2003*	**6,588**	**38**	**10,591**	**62**	**17,179**	**4,854**	**3,254**
2004*	**11,481**	**53**	**10,221**	**47**	**21,702**	**2,689**	**1,496**
10 YR AVE.	7,114	33	12,028	67	19,142	3,319	2,084
AVE. ALL YRS	2,307	70	5,764	30	4,869	798	1,992

* PRELIMINARY, SUBJECT TO REVISION

SUMMER STEELHEAD
GOLD RAY DAM
Run Period: May 15- Dec. 31
(Count period used by management)

Year	# Wild	%wild	# Hatchery	%hatch	Total
1942	7,387	100		0	7,387
1943	5,648	100		0	5,648
1944	5,530	100		0	5,530
1945	7,302	100		0	7,302
1946	4,448	100		0	4,448
1947	3,221	100		0	3,221
1948	2,133	100		0	2,133
1949	3,618	100		0	3,618
1950	4,583	100		0	4,583
1951	3,262	100		0	3,262
1952	4,200	100		0	4,200
1953	3,831	100		0	3,831
1954	2,222	100		0	2,222
1955	1,703	100		0	1,703
1956	2,753	100		0	2,753
1957	1,323	100		0	1,323
1958	1,293	100		0	1,293
1959	865	100		0	865
1960	2,034	100		0	2,034
1961	2,408	100		0	2,408
1962	3,603	100		0	3,603
1963	1,508	100		0	1,508
1964	778	100		0	778
1965	2,144	100		0	2,144
1966	2,092	100		0	2,092
1967	1,637	100		0	1,637
1968	693	100		0	693
1969	7,768	100		0	7,768
1970	5,163	85	925	15	6,088
1971	3,995	81	914	19	4,909
1972	3,148	88	411	12	3,559
1973	4,558	87	678	13	5,236
1974	5,740	73	2,118	27	7,858
1975	6,020	72	2,318	28	8,338
1976	2,583	73	946	27	3,529
1977	8,500	75	2,852	25	11,352
1978	3,980	80	997	20	4,977
1979	11,821	80	3,046	20	14,867
1980	5,285	68	2,488	32	7,773
1981	7,866	66	4,063	34	11,929
1982	9,021	66	4,633	34	13,654
1983	4,749	63	2,832	37	7,581
1984	4,972	67	2,425	33	7,397
1985	5,460	73	2,051	27	7,511
1986	8,603	59	5,995	41	14,598
1987	11,845	47	13,110	53	24,955
1988	10,414	54	8,869	46	19,283
1989	4,307	35	8,104	65	12,411
1990	1,446	24	4,513	76	5,959
1991	3,792	76	1,183	24	4,975
1992	1,601	46	1,906	54	3,507
1993	3,033	29	7,562	71	10,595
1994	2,736	25	8,349	75	11,085
1995	5,526	40	8,368	60	13,894
1996	2,876	25	8,804	75	11,680
1997	1,467	19	6,071	81	7,538
1998	3,199	53	2,857	47	6,056
1999	1,938	41	2,847	59	4,785
2000	2,489	37	4,245	63	6,734
2001*	**6,811**	**42**	**9,303**	**58**	**16,114**
2002*	**11,768**	**40**	**17,528**	**60**	**29,296**
2003*	**9,865**	**49**	**10,432**	**51**	**20,297**
2004*	**6,386**	**47**	**7,272**	**53**	**13,658**
10 YR AVE.	5,233	39	7,773	61	13,005
AVE. ALL YRS	4,491	76	4,886	24	7,206

SUMMER STEELHEAD
GOLD RAY DAM
Run Period: May 15- Jan. 31
(Count period used by research)

Year	# Wild	%wild	# Hatchery	%hatch	Total
1942	5,517	100		0	5,517
1943	5,665	100		0	5,665
1944	10,973	100		0	10,973
1945	7,436	100		0	7,436
1946	4,494	100		0	4,494
1947	3,244	100		0	3,244
1948	2,092	100		0	2,092
1949	3,629	100		0	3,629
1950	4,667	100		0	4,667
1951	3,300	100		0	3,300
1952	6,408	100		0	6,408
1953	4,503	100		0	4,503
1954	2,224	100		0	2,224
1955	2,625	100		0	2,625
1956	2,737	100		0	2,737
1957	2,110	100		0	2,110
1958	1,937	100		0	1,937
1959	1,506	100		0	1,506
1960	2,220	100		0	2,220
1961	2,522	100		0	2,522
1962	3,610	100		0	3,610
1963	1,754	100		0	1,754
1964	1,024	100		0	1,024
1965	3,437	100		0	3,437
1966	2,253	100		0	2,253
1967	1,923	100		0	1,923
1968	6,173	100		0	6,173
1969	9,432	100		0	9,432
1970	5,944	86	939	14	6,883
1971	4,366	83	906	17	5,272
1972	4,609	89	581	11	5,190
1973	5,068	86	812	14	5,880
1974	7,385	74	2,573	26	9,958
1975	6,746	73	2,438	27	9,184
1976	2,674	74	946	26	3,620
1977	10,371	77	3,184	23	13,555
1978	3,980	77	1,185	23	5,165
1979	11,831	72	4,600	28	16,431
1980	5,592	68	2,605	32	8,197
1981	7,955	66	4,098	34	12,053
1982	10,044	68	4,742	32	14,786
1983	5,038	64	2,845	36	7,883
1984	5,104	68	2,437	32	7,541
1985	8,348	77	2,501	23	10,849
1986	9,786	61	6,186	39	15,972
1987	12,959	49	13,346	51	26,305
1988	11,273	56	8,869	44	20,142
1989	5,613	40	8,358	60	13,971
1990	1,633	26	4,555	74	6,188
1991	3,231	73	1,208	27	4,439
1992	4,043	67	1,953	33	5,996
1993	4,067	36	7,228	64	11,295
1994	4,229	33	8,706	67	12,935
1995	5,905	41	8,402	59	14,307
1996	3,513	28	9,034	72	12,547
1997	1,507	20	6,203	80	7,710
1998	3,469	54	2,944	46	6,413
1999	2,325	44	2,955	56	5,280
2000	2,674	38	4,370	62	7,044
2001*	**7,901**	**44**	**10,223**	**56**	**18,124**
2002*	**16,768**	**45**	**20,280**	**55**	**37,048**
2003*	**11,038**	**50**	**10,834**	**50**	**21,872**
2004*	**7,136**	**48**	**7,589**	**52**	**14,725**
10 YR AVE.	6,224	41	8,283	59	14,507
AVE. ALL YRS	5,294	77	5,161	23	8,162

*** PRELIMINARY, SUBJECT TO REVISION**
Revised: 2/8/2005

WINTER STEELHEAD
GOLD RAY DAM
Run Period: Jan. 1 to May 15
(Count period used by management)

Year	# Wild	%wild	# Hatchery	%hatch	Total
1942	--	--	--	--	--
1943	15,314	100		0	15,314
1944	13,380	100		0	13,380
1945	16,083	100		0	16,083
1946	8,729	100		0	8,729
1947	9,653	100		0	9,653
1948	8,605	100		0	8,605
1949	8,052	100		0	8,052
1950	8,684	100		0	8,684
1951	5,744	100		0	5,744
1952	10,648	100		0	10,648
1953	10,945	100		0	10,945
1954	7,228	100		0	7,228
1955	5,239	100		0	5,239
1956	8,775	100		0	8,775
1957	4,508	100		0	4,508
1958	3,855	100		0	3,855
1959	4,550	100		0	4,550
1960	6,901	100		0	6,901
1961	8,965	100		0	8,965
1962	9,901	100		0	9,901
1963	9,024	100		0	9,024
1964	6,431	100		0	6,431
1965	7,310	100		0	7,310
1966	12,463	100		0	12,463
1967	5,150	100		0	5,150
1968	7,235	100		0	7,235
1969	6,559	100		0	6,559
1970	13,789	100		0	13,789
1971	9,208	98	234	2	9,442
1972	15,964	95	862	5	16,826
1973	8,894	93	672	7	9,566
1974	6,560	92	548	8	7,108
1975	9,226	89	1,141	11	10,367
1976	5,705	94	343	6	6,048
1977	4,235	89	489	11	4,724
1978	6,783	86	1,084	14	7,867
1979	9,901	78	2,866	22	12,767
1980	8,820	66	4,551	34	13,371
1981	6,400	78	1,797	22	8,197
1982	4,710	74	1,627	26	6,337
1983	8,170	84	1,558	16	9,728
1984	5,231	55	4,255	45	9,486
1985	9,131	87	1,331	13	10,462
1986	14,457	87	2,207	13	16,664
1987	13,990	80	3,597	20	17,587
1988	12,096	81	2,923	19	15,019
1989	10,288	70	4,307	30	14,595
1990	8,027	77	2,460	23	10,487
1991	3,106	68	1,441	32	4,547
1992	3,247	79	887	21	4,134
1993	4,864	75	1,615	25	6,479
1994	5,545	84	1,036	16	6,581
1995	10,121	81	2,313	19	12,434
1996	7,717	84	1,451	16	9,168
1997	12,155	81	2,802	19	14,957
1998	3,814	76	1,215	24	5,029
1999	7,997	84	1,500	16	9,497
2000	5,585	82	1,222	18	6,807
2001*	**6,644**	**74**	**2,300**	**26**	**8,944**
2002*	**11,046**	**50**	**11,241**	**50**	**22,287**
2003*	**15,558**	**63**	**9,292**	**37**	**24,850**
2004*	**14,293**	**65**	**7,596**	**35**	**21,889**
10 YR AVE.	9,493	74	4,093	26	13,586
AVE. ALL YRS	8,000	89	2,493	11	9,967

WINTER STEELHEAD
GOLD RAY DAM
Run Period: Feb. 1 to May 15
(Count period used by research)

Year	# Wild	%wild	# Hatchery	%hatch	Total
1942	--	--	--	--	--
1943	16,708	100		0	16,708
1944	14,122	100		0	14,122
1945	9,552	100		0	9,552
1946	8,284	100		0	8,284
1947	9,219	100		0	9,219
1948	8,519	100		0	8,519
1949	7,913	100		0	7,913
1950	8,593	100		0	8,593
1951	5,464	100		0	5,464
1952	10,683	100		0	10,683
1953	8,627	100		0	8,627
1954	6,763	100		0	6,763
1955	5,173	100		0	5,173
1956	7,830	100		0	7,830
1957	5,033	100		0	5,033
1958	3,101	100		0	3,101
1959	4,111	100		0	4,111
1960	6,894	100		0	6,894
1961	9,418	100		0	9,418
1962	10,891	100		0	10,891
1963	9,794	100		0	9,794
1964	5,855	100		0	5,855
1965	6,841	100		0	6,841
1966	11,170	100		0	11,170
1967	4,989	100		0	4,989
1968	6,949	100		0	6,949
1969	6,056	100		0	6,056
1970	12,126	100		0	12,126
1971	8,438	98	209	2	8,647
1972	15,651	95	812	5	16,463
1973	7,423	94	512	6	7,935
1974	6,054	94	410	6	6,464
1975	7,438	90	829	10	8,267
1976	5,015	96	187	4	5,202
1977	4,130	89	503	11	4,633
1978	4,904	87	760	13	5,664
1979	9,761	78	2,818	22	12,579
1980	8,865	75	2,942	25	11,807
1981	5,729	77	1,743	23	7,472
1982	4,579	74	1,634	26	6,213
1983	7,145	83	1,451	17	8,596
1984	5,445	59	3,739	41	9,184
1985	8,973	87	1,345	13	10,318
1986	11,569	86	1,813	14	13,382
1987	12,677	78	3,536	22	16,213
1988	10,982	80	2,687	20	13,669
1989	9,429	69	4,307	31	13,736
1990	6,721	75	2,206	25	8,927
1991	2,919	68	1,399	32	4,318
1992	2,979	77	865	23	3,844
1993	4,345	73	1,568	27	5,913
1994	4,940	85	888	15	5,828
1995	8,628	82	1,956	18	10,584
1996	7,338	84	1,417	16	8,755
1997	11,518	82	2,572	18	14,090
1998	3,774	78	1,083	22	4,857
1999	7,727	85	1,413	15	9,140
2000	5,198	82	1,114	18	6,312
2001*	**6,457**	**75**	**2,177**	**25**	**8,634**
2002*	**9,956**	**49**	**10,321**	**51**	**20,277**
2003*	**10,558**	**62**	**6,540**	**38**	**17,098**
2004*	**12,997**	**64**	**7,155**	**36**	**20,152**
10 YR AVE.	8,415	74	3,575	26	11,990
AVE. ALL YRS	7,918	89	2,203	11	9,127

7

Estimates of the Run Size of Rogue Basin Adult Coho Salmon Past Huntley Park, 1980-2004

YEAR	TOTAL N	TOTAL 95% C I	HATCHERY N	HATCHERY 95% C I	WILD N	WILD 95% C I
1980	5,388	1,929	4,402	1,744	986	825
1981	12,207	3,758	7,411	2,928	4,796	2,356
1982	715	561	122	231	593	511
1983	1,184	899	735	708	449	554
1984	10,564	3,594	3,717	2,132	6,847	2,894
1985	1,731	429	665	266	1,066	337
1986	4,451	2,454	3,258	2,100	1,193	1,270
1987	5,971	3,716	4,029	3,052	1,942	2,119
1988	14,368	3,272	8,858	2,569	5,510	2,027
1989	2,152	1,074	1,372	858	780	647
1990	3,306	4,502	255	1,251	3,051	4,325
1991	3,244	1,913	2,217	1,582	1,027	1,076
1992	3,422	2,917	1,214	1,737	2,208	2,343
1993	1,006	928	645	743	361	556
1994	12,651	1,700	7,212	1,284	5,439	1,115
1995	13,311	1,159	9,550	981	3,761	616
1996	13,321	1,109	8,699	896	4,622	653
1997	16,992	1,516	8,710	1,086	8,282	1,059
1998	5,447	859	3,131	651	2,316	560
1999	6,193	673	4,755	590	1,438	324
2000	21,083	2,320	10,117	1,607	10,966	1,673
2001	25,379	1,860	13,166	1,340	12,213	1,290
2002	20,559	1,547	12,759	1,218	7,800	953
2003	14,050	1,659	7,296	1,196	6,754	1,150
2004	33,573	3,629	9,092	1,888	24,481	3,099

Oregon

DEPARTMENT OF
FISH AND
WILDLIFE

MEMORANDUM

Date: July 15, 1994

To: Stephanie Burchfield

From: Frank Young Fxy

Subj: Site Visit to Savage Rapids Dam

I visited Savage Rapids Dam July 6-7, 1994 to become familiar with the project and its fish passage facilities. On the morning of July 7 Gerald Budziak, a Department employee with many years of experience working with the project fish passage facilities, provided a tour of the project and described how the various elements of the juvenile and adult fish passage facilities functioned.

In the past I have been involved in seeking solutions to fish passage problems at mainstem dams in the Snake and Columbia rivers for 27 of the 30 years that I was employed by ODFW. While most of my work focused on the mainstem dams, I also participated in design review and inspection of smaller juvenile and adult passage facilities throughout the basin including those in the Umatilla, Yakima, Wenatchee, Deschutes, Grande Ronde and Willamette basins.

Adult Passage

I found the adult fish ladders to be quite primitive compared to fish ladders in the Columbia Basin. The south shore ladder appeared to have three major problems. First, there is no automatic control section for adjusting the height of the weirs at the ladder exit to compensate for fluctuations in forebay level and there doesn't seem to be anyone assigned by the irrigation district to make timely adjustments when the forebay elevation changes. There was a drop of nearly

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2 feet from the exit weir (where there should have been only 1 foot) creating very turbulent conditions in the pool below. Secondly, the large pool in the middle of the ladder had water spilling into it from where a stoplog in the dam had been lifted about one foot to provide make-up water necessary to keep the lower half of the ladder fully watered. The plunge of about six feet created turbulence and a false attraction which could stimulate fish to jump and injure themselves on the rocks at the end of this pool. Thirdly, the ladder exit plunged nearly three feet to the tailrace (where a plunge of only one foot is desirable) causing considerable turbulence and filling the approach to the ladder entrance with bubbles. These bubbles reduce water density and make it more difficult for fish to jump the distance from the tailrace to the first pool. The most likely area for a fish to land when jumping to enter the ladder was on a rock apron off to one side of the ladder.

The north shore ladder suffered from the same lack of ability to be adjusted to compensate for the fluctuations in forebay elevation as the south ladder. In addition, attraction water for the ladder exit was augmented by piped water from the forebay plunging about six feet into the approach to the ladder entrance which produced great turbulence and bubbles at the ladder entrance.

It is my opinion that the cumulative effects of all of the adult passage problems mentioned above are likely resulting in a significant delay to adult fish in passing this area of the river. In both the Columbia and Willamette rivers we have found that any significant delay in upstream passage reduces the probability that delayed fish will spawn successfully.

<u>Juvenile Passage</u>

I believe that there are two potentially significant sources of mortality to juvenile salmonids associated with the project. First, the screen in the south bank canal does not meet criteria for approach velocity, increasing the likelihood of impingement of small fish when there is any debris buildup. Second, water velocity in the reservoir is greatly reduced from that of a river thereby increasing the amount of time juveniles are exposed to predation. The reservoir also increases average water depth, silhouetting juveniles, which travel primarily in the top 15 feet, and thereby making them more vulnerable to predators feeding from below. In addition, since juvenile fish are passed primarily through spill over the dam into extremely turbulent conditions, there is the potential for substantial losses of disoriented juveniles through predation by northern squawfish and predaceous birds.

Conclusions

Under the much better passage facilities of the Columbia River, losses of adult salmonids average about 5-10% per dam. Losses of adult salmonids under the conditions at Savage Rapids Dam could be considerably higher depending upon the flow and ladder entrance and exit conditions at the time of peak passage. I believe that a range of 10-30% adult passage loss is possible based on my observation and experience.

Losses of juvenile fish from predation average about 10% per project for Columbia River dams. I would expect losses of a similar magnitude from predation at Savage Rapids Dam, depending on flow and temperature, with higher losses for juveniles which pass during lower flows and higher temperatures. Additional losses from impingement on the diversion screens could be substantial. At screen facilities where approach velocities meet ODFW standards of 0.8 ft/sec for yearling-sized fish and 0.4 ft/sec for subyearling fish, mortality ranges from 0-5%. When these approach velocities are not met, mortality rates are higher, primarily caused by impingement on the screens when fish can no longer maintain sustained swimming speeds and give up in exhaustion. Given that the approach velocity for the irrigation diversion screens at Savage Rapids Dam are 1.5 ft/sec on the north shore and 1.0 ft/sec on south shore, I believe that mortality rates ranging from 5-30% on diverted fish could be expected.

I believe that losses to juvenile fish from all causes at Savage Rapids Dam may average 10-15%, although actual losses could be much higher.

c.

Nigro

Oregon

DEPARTMENT OF FISH AND WILDLIFE

MEMORANDUM

DATE: February 9, 1995

TO: Stephanie Burchfield, HCD

FROM: Frank Young, Fish Division FY

SUBJECT: Summary of Recent Research on Passage of Juvenile and Adult Salmonids at State-of-the-Art Fish Screen and Ladder Facilities, and Implications for Savage Rapids "Dam Retention" Alternative

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This memo is in response to your request that I examine results of existing research on state-of-the-art fish passage facilities and relate this information to expected survival rates of salmonids at Savage Rapids Dam under the "Dam Retention" alternative. My understanding is that with this alternative, state-of-the-art facilities would replace existing facilities and that monitoring, operations and maintenance would be continued following construction.

Juvenile Fish Passage at State-of-the-Art Rotating Drum Screen Facilities

Fisheries biologists and engineers in the Pacific Northwest generally agree that the safest and most reliable screen design for bypassing juvenile salmonids around a diversion intake is the rotating drum screen set at an angle to incoming flow. In the early 1980's, National Marine Fisheries Service (NMFS), Washington Department of Fisheries (WDF) and Oregon Department of Fish and Wildlife (ODFW) developed design criteria based on studies of fish swimming capabilities and evaluations of existing screens. For fry-sized fish (often called "zero-age"), these criteria included an approach velocity of no greater than 0.5 feet per second and a screen mesh size no greater than 0.125 inches in any direction. In the late 1980's, the agencies lowered the design approach velocity criterion to 0.4 fps for fry-sized fish based on evidence of impingement at the higher velocity. In the last year, the agencies have considered decreasing the criterion for mesh size to 3/32 or 0.0938 inches based on evaluations of screens built during the 1980's that showed fry-sized fish were able to pass through screens with mesh size equal to or greater than 0.125 inches. NMFS is expected to adopt revised criteria that include this decreased mesh size in early 1995. The study results summarized in this section were conducted at facilites designed to meet either the 0.5 or 0.4 feet per second approach velocity and 0.125 inches mesh size criteria.

Neitzel et al (1985) evaluated chinook salmon and steelhead smolts released above rotating drum screens at the Sunnyside Canal on the Yakima River in Washington. They concluded that these smolts were safely diverted to the Yakima River. Less than 2 percent of the chinook salmon smolts were descaled or dead following passage by the screens, and none of the steelhead smolts were descaled or dead.

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In 1986, Neitzel et al (1987) conducted similar evaluations at the Richland and Toppenish/Satus canal fish screening facilities, located on the Yakima River and Toppenish Creek, respectively. Spring chinook and steelhead smolts and fall chinook fry were tested in this study. No significant difference in injury was detected between test and control groups for all species. The authors concluded that both screens safely divert fish from the canals back to the river. Although the authors observed no increase in predation because of the screening facilities, they noted that predatory fish populations could increase in subsequent years and should be reevaluated after several years of continuous operation of the screening facilities.

The Richland and Wapato Canal rotating drum screens on the Yakima River were evaluated by Neitzel et al (1988) in spring, 1987. Descaling and injury rates for test groups of both steelhead and spring chinook smolts were not signficantly different from control groups. At the Richland screens, no loss of fall chinook fry was found resulting from either impingement or passage through the screens. At the Wapato screens, Neitzel estimated 3 to 4 percent of the fall chinook fry were lost from either impingement or passage through the screens or screen seals.

In spring, 1988, Neitzel et al (1990a) conducted evaluations of the rotating drum screens at Wapato, Sunnyside, and Toppenish Creek canals. The authors concluded that fish are neither descaled or killed during passage at the rotating drum screens. They also concluded that although screening facilities could exacerbate predation on juvenile salmonids because of stress, injury or delayed migration, they did not observe loss to predation at these three facilities.

Neitzel et al (1990b) conducted evaluations of the Westside Ditch and Wapato Canal rotating drum screening facilities in 1989. No significant difference in descaling and injury was detected between test and control groups of steelhead and chinook salmon smolts. At the Westside Ditch screens, however, 25 percent of the chinook fry, zero-age fish, passed through the screens. Design criteria for these screens followed the 0.5 feet per second approach velocity and 0.125 inches mesh size criteria recommended by the fisheries agencies in the early 1980's.

The Westside Ditch and Town Canal rotating drum screens on the Yakima River were evaluated by Neitzel et al (1990c) in spring 1990. The authors found no significant difference in descaling between test and control groups of steelhead smolts at the Town Canal. They concluded that 8.5 percent of the native zero-age chinook salmon fry at the Town Canal and 16.8 percent of the same species at the Westside Ditch were lost as a result of passage through the screens. These fish (presumably spring chinook salmon) were mostly less than 36 mm in length. Screen mesh size at both facilities was 0.125 inches.

In 1987 through 1989, Hosey and Associates (1990) evaluated angled rotating drum screens at the Columbia, Chandler, Roza and Easton facilities on the Yakima River in Washington. The authors estimated less than 1 percent of the smolt- and fry-sized spring chinook, fall chinook and steelhead were either descaled or killed as a result of bypass by the screens. Although there was no evidence of fish passing through the screens at Columbia, Chandler or Roza, some spring chinook fry and smolt-sized fish were lost at Easton. The authors attributed this loss to inadequate screen seals. Predation was not considered a major problem during the study period. Avian predation (gulls) was observed at the Columbia facility. Squawfish predation at the Chandler facility was identified as a potential problem during periods of warm water temperatures. The screens at these four facilities were designed to meet design criteria of 0.5 feet per second approach velocity and 0.125 inches mesh size.

In the Umatilla River in Oregon, Hayes et al (1992) evaluated juvenile fish passage at a rotating drum screening facility in the West Extension Irrigation District Canal at Three Mile Falls Dam. The authors detected no significant difference in injury rates between test and control groups of spring chinook, fall chinook and summer steelhead smolts. Screen efficiency was estimated at 99.8 percent, which means that approximately 0.2 percent of the test fish passed through or over the screens into the canal. Screen mesh size was 0.125 inches and design approach velocity was 0.5 feet per second at this facility.

Similar studies were conducted at Furnish Canal on the Umatilla River in 1994. Highest screen efficiency rates were measured when gaps were sealed with foot and top wedges on drum screens and an improved bottom seal mount design was utilized (Cameron et al, 1995).

The need to keep rotating drum screening facilities in proper operating condition was stressed in several studies, including 1993 and 1994 evaluations of new facilities in the Umatilla River (Cameron et al, 1994 and 1995). Proper maintenance is also needed to keep facilities within design criteria.

Juvenile Fish Passage at Vertical Traveling Screen Facilities

Hydraulic design standards for vertical traveling screens are the same as for rotating drum screens. If vertical traveling screens are designed to these standards, including such important factors as uniform distribution of flow approaching the screens, adequate sweeping velocity across the screens, adequate bypass entrance velocity and large bypass entrances, there is no reason why fish survival at this type of screen would not be as high as that encountered at rotating drum screens (Rainey, personal communication). Rainey cautioned, however, that because there are more mechanical parts to vertical traveling screens than rotating drum screens, the likelihood of mechanical failure is greater, which would result in more instances of screen shutdown and potential acute fish mortalities.

Few vertical traveling screens have been installed in recent years that meet current design standards. In the Yakima River basin, where many rotating drum screens were installed in the 1980's, vertical traveling screens have also been installed as secondary screens at two facilities. Both the Chandler and Roza facilities have vertical traveling screens located in the juvenile bypass system after fish have passed the rotating drum screens to bleed off excess bypass flow and pump it back into the canals (Rainey, personal communication). These screens were designed for an approach velocity of 0.4 feet per second and screen mesh size of 0.125 inches. Hosey and Associates (1990) evaluated the vertical traveling screens as part of the entire screen facility survival study described above with reference to rotating drum screens. Overall mortality rates of less than 1 percent were calculated for juvenile fish diverted first by the rotating drum screens and then by the vertical traveling screens.

Vertical traveling screens have also been installed as secondary screens at the West Extension Irrigation District diversion at Three Mile Falls Dam on the Umatilla River (Cameron and Knapp, 1993). Fish impingement on these screens was determined to be a problem when velocities through the screen were too high. The authors concluded that placement of a restrictive orifice downstream of the traveling screen created unfavorable hydraulics at the traveling screen.

The Marmot Dam vertical traveling screens on the Sandy River were evaluated over a thirteen-year period from 1980 through 1993 by Portland General Electric (Cramer, 1993). Numerous modifications were made to the screen facility over the years to improve fish passage problems identified in evaluations. Screen mesh size is currently 0.125 inches. Approach velocity averages 1.1 feet per second, yet ranges from 0.5 to 1.9 due to uneven flow distribution across the screen. The screen is set perpendicular to the flow, and thus there is no sweeping velocity to guide fish to the bypass entrances. Instead, a spray wash system was installed to spray impinged fish off the screen and into a conveyance to the bypass pipe. Mortality of salmon and steelhead fry (35 mm to 50 mm in length) has been reduced as a result of the spray wash system, although mortality continues to be strongly affected by changes in spray wash pressure, direction of spray nozzles, and canal water surface elevation. PGE concluded that 95.4 percent of salmon and steelhead fry survive passage around the screens under average conditions. PGE noted that fry survival might be increased to 98 percent with additional modifications. Hatchery spring chinook and steelhead smolts survived at rates of 95 percent and 97.3 percent, respectively. Survival of wild smolts and other juvenile fish over 50 mm was estimated between 95 percent and 100 percent, but test fish numbers were too low for accurate estimation.

<u>Adult Fish Passage at State-of-the-Art Vertical Slot Ladder Facilities</u>

Few controlled survival studies have been conducted at vertical slot fishways. Most studies to evaluate vertical slot and other fishways have compared rates of fish passage under various operating scenarios, evaluated fallback of adult fish that successfully passed over a dam, identified pooling of fish below a dam or jumping of fish at spillways or other water sources, or evaluated fish delay associated with dam passage.

Fish passage rates and success are largely affected by the distribution of discharge from a dam and the effectiveness of the attraction flows at the fishway entrance (Bjornn and Peery, 1992). Bjornn noted that spill at dams should be shaped to avoid false attraction of adult fish to the spillway rather than to fish ladder entrances. Fishway entrances on both banks of the river, with added attraction flows at the entrances, provide good conditions for fish passage. Bjornn also discussed the location of fishway exits in relation to spillways. If exits are located too close to spillways, fish are more likely to fallback over the dam during high spill rates.

In 1991 and 1992, Hockersmith <u>et al</u> (1994) evaluated passage of adult spring chinook salmon in the Yakima River with radio telemetry equipment. They concluded that migration delays for radio-tagged spring chinook salmon at Yakima River basin dams were similar or less than passage times at Columbia and Snake River dams. Median passage times were less than one day at all of the dams equipped with state-of-the-art vertical slot ladders except at the upper elevation dams where fish were probably holding during the prespawning period. Wapatox Dam on the Naches River, a tributary to the Yakima River, had not been retrofitted with vertical slot ladders. Its existing pool and weir fishway did not pass spring chinook salmon as quickly compared to the other dams. Median passage times were 3.5 days in 1991 and 4.2 days in 1992. Only 7 percent of the radio-tagged fish in 1991 died during the approximate 100 to 150 mile migration from Prosser Dam to spawning grounds in the upper basin. In 1992, mortality associated with migration was estimated at 3 percent. Since these fish passed over 4 to 6 dams in their migration to spawning grounds, it appears that fish ladder passage did not contribute significantly to mortality.

The Technical Advisory Committee (TAC) for U.S. v. Oregon management of anadromous fish harvest in the Columbia River has prepared models of fish survival through the Columbia River dams in its biological assessments of fish harvests under the Endangered Species Act. These models are based on current field studies, harvest information, and daily fish counts at the dams. In 1994, the TAC assumed adult fall chinook losses of 5 percent per dam for the dams from Bonneville to McNary on the Columbia River. The TAC's estimate of adult spring chinook losses in 1995 is 8 percent per dam from Bonneville to McNary on the Columbia River and 5 percent per dam through the four dams on the lower Snake River (Technical Advisory Committee, 1994 and 1995). Because these dams are much larger than Savage Rapids Dam, I would assume that adult fish mortality rates at state-of-the-art fish ladders at Savage Rapids would be even lower than those assumed for the Columbia and Snake River dams.

Recommendations for Modeling Anticipated Passage Success at Savage Rapids Dam under the "Dam Retention" Alternatiive

Rotating Drum Screens: The "Dam Retention" alternative at Savage Rapids Dam calls for a state-of-the-art angled, rotating drum screen facility to be constructed at the Gravity Canal diversion on the south bank of the river. At the time the initial conceptual designs for this facility were developed, design criteria of 0.4 feet per second approach velocity and 0.125 inches screen mesh were assumed. I recommend that, if this alternative is chosen, the most recent design criteria be used to ensure best possible fish protection. At this time, an approach velocity of 0.4 feet per second and screen mesh of 3/32 or 0.0938 inches are recommended design criteria by National Marine Fisheries Service where fry-sized salmonids are present. Given the results of recent research studies listed above and assuming that the new facilities will be operated and maintained in prime condition, I believe juvenile fish mortality for all species associated with the rotating drum screen facility should range from 0 to 5 percent.

Vertical Traveling Screens: The "Dam Retention" alternative also calls for installation of vertical traveling screens at the pump-turbine diversion on the north bank of the river. Conceptual design criteria call for 0.4 feet per second approach velocity and 0.125 inch screen mesh. As stated above regarding the rotating drum screens, I recommend that the most recent design criteria, notably screen mesh of 0.0938 inches, be utilized if this alternative is chosen. It is reasonable to assume that juvenile fish survival at the proposed screens would be greater than that measured at existing screens which do not meet "state-of-the-art" design criteria. Given the results of research studies listed above and considering improvements that the proposed screens would exhibit that are lacking in screens at Marmot Dam, I believe juvenile fish mortality for all species associated with the vertical traveling screens should range from 0 to 5 percent. These screens must also be properly operated and maintained to ensure that fish mortality does not increase above the 0 to 5 percent range.

Fish Ladders: Both the north and south bank fishways would be replaced under the "Dam Retention" alternative with vertical slot ladders that meet current design standards. Based on both actual field studies in the Yakima River basin where state-of-the-art vertical slot fishways have been installed and on model calculations of fish survival through the Columbia and Snake river dams, I believe that adult fish losses and delay at Savage Rapids Dam with the new fishways would be greatly reduced from current conditions. It is my understanding that the dam retention alternative would include modifications to the river channel below the dam to eliminate false attraction flows that currently pose serious impediments to adult fish passage. I suggest using a range of 0 to 3 percent mortality for all adult salmon and steelhead species at the project.

Other Potential Sources of Fish Mortality: This memo does not summarize research results on other sources of mortality at dams, such as spillway mortality, predation and acute losses caused by emergency shutdown or screen failure.

- Spillway: Most studies of state-of-the-art spillways that include good plunge pools show insignificant fish mortality. When adequate plunge pools are provided, the only source of mortality has been associated with high levels of dissolved gases. This situation only occurs at high rates of spill over much higher dams than Savage Rapids and is usually limited to rivers with several dams in progression. Since none of these factors are present at Savage Rapids Dam, I would assume that spillway fish mortality would be essentially zero with the new facilities planned under the dam retention alternative.

- Predation: Studies have shown that predation on juvenile fish by other fish and birds is usually higher in the forebay and tailrace of a dam than in a normal riverine environment. However, my experience studying predation in the Columbia River has indicated that these predators are successful because inadequate hydraulic conditions exist at fish bypass entrances and outlets, resulting in juvenile fish that are easy prey for predators. If the fish facilities at Savage Rapids Dam under the dam retention alternative are designed to optimize hydraulic conditions for fish, predation should be minimized. Without site specific information about predation, I am unable to estimate a mortality rate associated with predation for the dam retention alternative.

- Emergency shutdown: Fish losses can be severe when facilities shutdown unexpectedly, especially if no one is stationed on-site on a 24-hour basis. If juvenile or adult fish are trapped in a holding pool and flow is cut off, dissolved oxygen can be quickly depleted and the fish will die. Other problems, such as debris buildup on screens, tears in screens or improperly fitted screen seals, can result in large numbers of fish diverted into irrigation canals before the screen failure is detected. With rotating drum screens, a spare drum can be kept on-site to replace one that needs maintenance. Vertical traveling screens, however, are not so simple to replace, and it may take days or even weeks to repair or replace such screens. The key to reducing the probability of acute losses is to institute a comprehensive operation and maintenance plan, including regular inspections. Because I am unaware of the extent of maintenance planned for the dam retention alternative, I am unable to estimate a mortality rate associated with acute incidents.

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ESTIMATION OF ROGUE RIVER SALMON AND STEELHEAD POPULATION INCREASES FOR THE SAVAGE RAPIDS "DAM RETENTION AND IMPROVEMENT" OPTION

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Background

This report presents the second part of an assessment by Oregon Department of Fish and Wildlife (ODFW) of the impacts of Savage Rapids Dam on Rogue River salmon and steelhead populations. The first report, "Estimation of Rogue River salmon and steelhead population increases for the the Savage Rapids 'Dam Removal' option" (October, 1994), presented results of a model analysis of population increases that would be expected if Savage Rapids Dam were removed. This assessment utilizes the same model to estimate expected population increases under a second alternative, dam retention and fish passage improvement.

The dam retention and improvement alternative is described in the U.S. Bureau of Reclamation's report, "Planning Report/Draft Environmental Statement of Fish Passage Improvement -- Savage Rapids Dam" (December, 1994). In addition to numerous modifications to improve dam safety and irrigation diversion structures, significant changes would be made to improve fish passage at the dam. All new facilities would be designed using state-of-the-art features to meet current design criteria. These include the following:

- Replacement of existing screens at the north bank pumping plant intake with vertical traveling screens
- Replacement of existing screens at the south bank gravity canal with rotating drum screens
- Replacement of north and south bank fish ladders with two vertical slot ladders
- Replacement of existing radial spill gates with new spillways and improved gate control system
- Construction of a plunge pool below the spillway to improve conditions for fish passing over the spillway
- Restructuring of the river channel below the dam to improve attraction flows to the fish ladders

As in the first report on the dam removal option, the following analysis makes use of modeling techniques for mathematically predicting population increases given improvements in fish

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survival associated with changes at the dam site. These techniques allow rapid and credible estimates, but without the great expense of extended and time-consuming data collection and analysis. By this technique ODFW biologists are able to estimate the lowest probable level of fish increases expected from dam retention and improvement, as well as the highest probable level. These low and high estimates are based on field studies at other dams where similar fish screens and ladders have been installed and evaluated. The low and high estimates are used to set the reasonable boundaries, within which the actual population number will lie. Because a number of factors influence this number from year to year, the actual population number will vary yearly, but this variation is expected to fall within the low and high boundaries discussed above.

Approach

High and low values for upstream and downstream fish loss rates are assumed for the improved fish passage facilities that would be installed under the dam retention alternative. These ranges are based on field studies at other dams where similar, state-of-the-art fish passage facilities have been installed. The attached memorandum from Frank Young, ODFW, February 9, 1995, summarizes existing research and recommends appropriate ranges for this analysis. Young's memorandum assumes no juvenile or adult fish mortality associated with passage over the improved spillway. Acute losses caused by emergency shutdown or facility failure are not included in Young's estimates of expected fish losses. It also assumes that losses of juvenile fish to predation are the same for the alternatives of dam retention and dam removal. We make this assumption because we cannot predict whether Umpqua squawfish will colonize the area around Savage Rapids Dam.

Umpqua squawfish are not native to the Rogue River and have spread upstream since they entered the Rogue River at Grave Creek in 1979. Recent sampling has shown that squawfish prey on juvenile salmon and steelhead in areas downstream of Grants Pass, especially in late spring (ODFW unpublished data). Work on the Columbia River indicates that losses of juvenile salmon to predation by squawfish is greatest in areas near dams (Tabor et al. 1993; Petersen 1994) and that predation losses may be as high as 11 percent (Rieman et al. 1991). Thus, retention of Savage Rapids Dam may result in greater predation losses of juvenile salmon and steelhead than would be expected from the dam removal alternative.

Other than the parameters described above that characterize expected losses at improved fish passage facilities, this model utilizes the same calculations and parameter values as were used in the first report. This includes estimates of adult fish passing Gold Ray Dam, ocean and river harvests, hatchery releases, and smolt-to-adult survival rates. The dam removal alternative calculated fall chinook salmon production associated with increased spawning habitat in the area presently inundated by the reservoir. These calculations are omitted from the dam retention alternative, because with dam retention the reservoir will continue to inundate this habitat, making it unavailable for spawning.

The model estimates annual increases in harvest and spawning populations of salmon and steelhead based on the difference between estimated losses under present dam conditions and losses expected with the dam retention and improvement alternative. Improved fish passage facilities at the dam will result in net increases in salmon and steelhead production in the Rogue River as compared to current conditions.

Details and calculations associated with ODFW's estimate are contained in the attached tables 1 through 13.

Results

Tables 1 through 5 show the assumptions and calculations that were made to estimate "low range" annual increases in harvest and spawning populations of spring chinook, fall chinook, summer steelhead, winter steelhead, and coho salmon. The low range increases are based on the highest expected mortality rates for the proposed fish passage facilities and the lowest mortality rates assumed for the existing facilities. For the proposed facilities at Savage Rapids Dam, an upstream adult fish mortality rate of 3 percent and a downstream juvenile fish mortality rate of 5 percent are assumed (Young 1995). The tables cite sources of data and assumptions used in the mathematical computations. The "Literature Cited" section provides full reference information for these sources.

Table 6 is a summary table that lists "low range" estimates for each species. Based on the assumptions in this model, we estimate that an additional 5,515 salmon and steelhead would be available for harvest and spawning annually if the Savage Rapids Dam retention and improvement alternative were implemented.

Tables 7 through 11 represent "high range" estimates of annual salmon and steelhead increases based on the lowest expected mortality rates for the proposed facilities and the highest mortality rates assumed for the existing facilities. For the proposed facilities, upstream and downstream fish mortality rates of 0 percent are assumed (Young 1995). Table 12 summarizes the "high range" estimates for each species, and shows a combined "high range" estimate for all species of 90,358.

Table 13 summarizes previous tables and shows the range of additional fish available for harvest and spawning for each species. Figure 1 shows this information for each species in graphic form. For all species combined, our estimates range from a low of 5,515 to a high of 90,358.

Conclusions

The range of numbers obtained, 5,515 to 90,358 fish annually, represents a reasonable range of estimates for expected salmon and steelhead population increases attributable to the Savage Rapids Dam retention and improvement alternative. As stated above, actual increases will vary yearly, and are highly dependent on run sizes, harvest rates and proper operation and maintenance of fish passage facilities.

In our first report, ODFW estimated 20,865 to 93,542 additional fish would be expected under the dam removal alternative. Figure 2 shows the ranges of additional fish estimated for both the dam removal and the dam retention alternatives. The large difference in low range estimates reflects both the relatively high rates of fish loss possible at state-of-the-art fish passage facilities and the assumption that existing fish passage losses at the dam are low. For the high range estimates, this difference results primarily from the fact that fall chinook spawning habitat in the reservoir area will be made available with the dam removal option but not with the dam retention alternative. The high range estimates for both alternatives are very close because juvenile and adult fish mortality associated with dam passage is assumed to be zero under the dam retention alternative. This assumption is extremely optimistic, because it requires new facilities to be continuously operated in "like new" condition. Young (1995) states that the range of fish mortality rates he suggests for the dam retention alternative are what one would expect if the facilities are operated and maintained in prime condition. Moreover, this analysis does not account for fish losses that would likely be incurred under the dam retention alternative from acute incidents such as screen failure and ongoing losses caused by spillway passage and increased predation.

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Table 1. Estimated Spring Chinook Salmon Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - Low Range

Adult Production = Upper river (UR) returns + River harvest + Ocean harvest

Assumptions:

UR returns =	31,126	Source: Gold Ray Dam counts, 1942 - 93 average
Lower river harvest rate =	28%	Source: Cramer et al, 1985, p. 255 (1964-81); does not include jacks
Ocean harvest =	43,397	Source: Satterthwaite, 1987, p.27, Table 9; catch:escapement = 1:1

Calculations:

River harvest = 0.28(Total fish at mouth) = 0.28(UR return +River harvest) = 0.28 (UR return)/(1-0.28)

River harvest = 0.28(31,126)/0.72 = 12, 105

Upper R. Returns	+ River Harvest	+ Ocean Harvest =	Adult Production
31,126	12,105	43,397	86,628

Upstream adult passage at dam

Assumptions:

SRD adult loss existing conditions (low range) =3,458 — Source: Burchfield et al, 1994, Table 7

SRD adult loss with dam ret. alt.=3%(Adults at base of SRD) — Source: Young, 1995 (estimated range 0-3% adult passage loss)

Assume no loss between Savage Rapids (SRD) and Gold Ray (GRD) dams

Calculations:

Adults at base of SRD = GRD counts +SRD Upstream Loss = GRD counts + 0.03(Adults at base of SRD)

0.97(Adults at base of SRD) = GRD counts

Adults at base of SRD = GRD counts/0.97 = 31,126/0.97 = 32,089

Adults at base of SRD	x SRD adult loss rate =	Adult loss with dam retention alternative
32,089	3%	963

Adult increase = Adult loss under existing conditions - adult loss expected with dam retention alternative

= 3,458 - 963 = 2,495 =Adult increase (upstream passage) with dam retention alternative

Downstream juvenile passage at dam

Assumptions:

SRD adult equivalent loss existing conditions (low range) =2,868	Source: Burchfield et al, 1994, Table 7
SRD juvenile mortality = 5%(smolts migrating to SRD)	Source: Young, 1995 (estimated range 0-5%)
Hatchery smolts produced = 1,458,000	Source: ODFW, hatchery release data, 1986-94
Wild smolts produced = 1,410,000	Source: ODFW unpublished data, mean for 1976-90
Hatchery smolt-to-adult survival rate = 2%	Source: ODFW, hatchery data, includes harvest
Wild smolt-to-adult survival rate = 2%	Source: Satterthwaite, 1994, personal communication.

Table 1, continued. Estimated Spring Chinook Salmon Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - Low Range

Downstream juvenile passage at dam, continued

Calculations:

SRD juvenile loss (hatchery) = 5%(1,458,000) = 72,900
SRD juvenile loss (wild) = 5%(1,410,000) = 70,500

Adult equivalent loss with dam ret. alt = (SRD hatchery juvenile loss x hatchery smolt-to-adult survival rate) + (SRD wild juvenile loss x wild smolt-to-adult survival rate) = (72,900 x 0.02) + (70,500 x 0.02) = 2,868

Adult equivalent increase = Adult equiv. loss existing conditions - adult equiv. loss with dam ret. alt.
= 2,868 - 2,868 = 0 = Adult equiv. increase (downstream passage) with dam retention alternative

Total Spring Chinook Increase		Upstream Passage		Adult Equiv. Downstream Passage
2,495	=	2,495	+	0

Table 2. Estimated Fall Chinook Salmon Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - Low Range

Above Savage Rapids Adult Production = Upper river run at mouth + Ocean harvest of fish originating above SRD

Assumptions:

Upper river run at mouth = Spawning escapement + River harvest + lower river prespawning mortality
Spawning escapement = Gold Ray Dam counts + Spawning between SRD and GRD
Gold Ray Dam counts = 3,148 Source: Gold Ray Dam counts, 1942 - 93 average
Spawning between SRD and GRD = 9,350 Source: Satterthwaite, 1992 (500 fish/km)
River harvest = 9.5% (upper river run at mouth) Source: ODFW, 1992, p.78, 1974-86 average
Prespawning mortality = 20%(upper river run at mouth) Source: Satterthwaite, personal communication
Ocean harvest = 2(upper river run at mouth) Source: Satterthwaite, personal communication, assume C:E = 2:1 for upper river fall chinook

Calculations:

Spawning escapement = 3,148 + 9,350 = 12,498
Upper river run at mouth = 12,498 + 0.095(upper run) + 0.20(upper run)
Upper run(1-0.095-0.20) = 12,498
Upper run = 12,498/0.70 = 17,728
River harvest = (0.095)(17,728) = 1,684
Prespawning mortality = (0.20)(17,728) = 3,546
Ocean harvest = 2(17,728) = 35,456
Above Savage Rapids Adult Production = 17,728 + 35,456 = 53,184

Table 2, continued. Estimated Fall Chinook Salmon Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - Low Range

Upstream adult passage at dam

Assumptions:

SRD adult passage loss existing conditions (low range) =1,389 — Source: Burchfield et al, 1994, Table 8

SRD adult loss with dam ret. alt.=3%(Adults at base of SRD) — Source: Young, 1995 (estimated range 0-3% adult passage loss)

Spawning escapement = Gold Ray Dam counts + Spawning between SRD and GRD = 12,498

Spawning escapement = 0.97(Adults at base of SRD)

Calculations:

Adults at base of SRD = Spawning escapement/(0.97) = 12,498/(0.97) = 12,884

SRD adult passage loss with dam ret. alt. = 0.03(12,884) = 387

Adult increase = Adult loss under existing conditions - adult loss expected with dam retention alternative

= 1,389 - 387 = 1,002 =Adult increase (upstream passage) with dam retention alternative

Downstream juvenile passage at dam

Assumptions:

SRD adult equivalent loss existing conditions (low range) = 886 — Source: Burchfield et al, 1994, Table 8

SRD juvenile mortality = 5%(juveniles migrating to SRD) — Source: Young, 1995 (estimated range 0-5%)

Wild juvenile-to-adult survival rate = 2% — Source: ODFW unpublished data, 1976-90 average

(Juveniles produced each year)(Juvenile-to-adult survival rate) = Upper river adult run at mouth

Adult equivalent loss with dam ret. alt. = (SRD juvenile mortality)(Juvenile-to-adult survival rate)

Calculations:

Juveniles produced = Upper river adult run at mouth/juvenile-to-adult survival rate = 17,728/0.02

Juveniles produced = 886,400

SRD juvenile mortality = 0.05(886,400) = 44,320

Adult equivalent loss with dam ret. alt. = (44,320)(0.02) = 886

Adult equivalent increase = Adult equiv. loss existing conditions - adult equiv. loss with dam ret. alt.

= 886 - 886 = 0 =Adult equiv. increase (downstream passage) with dam retention alternative

Total Fall Chinook Increase		Upstream Passage		Adult Equiv. Downstream Passage
1,002	=	1,002	+	0

Table 3. Estimated Summer Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - Low Range

Upstream adult passage at dam

Assumptions:

SRD adult loss existing conditions (low range) = 1,071	Source: Burchfield et al, 1994, Table 9
SRD adult loss with dam ret. alt. = 3% (Adults at base of SRD)	Source: Young, 1995 (estimated range 0-3% adult passage loss)
Gold Ray Dam counts = 6,016	Source: Gold Ray Dam counts, 1942 - 93, average
Returns between Gold Ray and Savage Rapids dams = 3624	Source: Satterthwaite, 1992

Upper river escapement = Gold Ray Dam Counts + Returns between Gold Ray and Savage Rapids

Upper river escapement = 0.97(Adults at base of SRD)

Calculations:

Upper river escapement = 6,016 + 3,624 = 9640

Adults at base of SRD = Upper river escapement/(0.97) = 9,640/(0.97) = 9,938

SRD adult passage loss with dam ret. alt. = 0.03(9,938) = 298

Adult increase = Adult loss under existing conditions - adult loss expected with dam retention alternative

= 1,071 - 298 = 773 = Adult increase (upstream passage) with dam retention alternative

Downstream juvenile passage at dam

Assumptions:

Most of river harvest is on half-pounders, produced above but harvested below SRD. (Does not include adult returns from half-pounders to avoid double counting).	Source: ODFW, 1994, p.189
SRD half-pounder equivalent loss existing conditions (low range) = 3,594	Source: Burchfield et al, 1994, Table 9
SRD juvenile mortality = 5% (juveniles migrating to SRD)	Source: Young, 1995 (estimated range 0-5%)
Hatchery juvenile-to-half-pounder survival rate = 12%	Source: ODFW, 1994, p.1, range = 3 - 28%, 1976-91 returns
Hatchery juveniles released = 144,523	Source: ODFW, 1994, p.134, 1974-91 average
(Current releases = 220,000)	Source: ODFW, hatchery release data, 1991-94
Juveniles migrating to SRD = 80% (Juveniles released each year)	Source: Evenson, personal communication, estimate

Half-pounder equivalent loss with dam ret. alt = (SRD juvenile mortality)(Juvenile-to-half-pounder survival rate)

Hatchery adults = 31% of total population passing Gold Ray Dam	Source: ODFW, 1994, p.51, 1970-91 brood years

Hatchery adults = 0.31(6,016) = 1,865

Hatchery adults = (1,865)/(9,640) = 19.3% of total adults passing Savage Rapids Dam

Table 3, continued. Estimated Summer Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - Low Range

Calculations:

Hatchery juveniles migrating to SRD = 0.80(144,523) = 115,618
SRD hatchery fish juvenile mortality = 0.05(115,168) = 5,758
Half-pounder equivalent loss hatchery fish with dam ret. alt. = (5,758)(0.12) = 691
Half-pounder equiv. loss wild + hatchery fish = half-pounder equiv. loss hatch. fish/percentage of hatchery adults of total passing SRD
Half-pounder equiv. loss wild + hatchery fish = (691)/(0.193) = 3,580
Half-pounder equiv. loss wild fish = 3,580 - 691 = 2,889
Half-pounder equivalent increase = Half-pounder equiv. loss existing conditions - half-pounder equiv. loss with dam ret. alt.
= 3,594 - 3,580 = 14 =Half-pounder equiv. increase (downstream passage) with dam retention alternative

Total Summer Steelhead Increase		Upstream Passage		Half-pounder Equiv. Downstream Passage
787	=	773	+	14

Table 4. Estimated Winter Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - Low Range

Upstream adult passage at dam

Assumptions:

SRD adult loss existing conditions (low range) = 1,486	Source: Burchfield et al, 1994, Table 10
SRD adult loss with dam ret. alt.=3%(Adults at base of SRD)	Source: Young, 1995 (estimated range 0-3% adult passage loss)
Gold Ray Dam counts = 9,317	Source: Gold Ray Dam counts, 1942 - 93, average
Returns between Gold Ray and Savage Rapids dams = 4056	Source: Satterthwaite, 1992

Upper river escapement = Gold Ray Dam counts + Returns between Gold Ray and Savage Rapids
Upper river escapement = 9,317 + 4,056 = 13,373
Upper river escapement = 0.97(Adults at base of SRD)

Calculations:

Adults at base of SRD = Upper river escapement/(0.97) = 13,373/(0.97) = 13,787
SRD adult passage loss with dam ret. alt. = 0.03(13,787) = 414
Adult increase = Adult loss under existing conditions - adult loss expected with dam retention alternative
= 1,486 - 414 = 1,072 =Adult increase (upstream passage) with dam retention alternative

Table 4, continued Estimated Winter Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - Low Range

Downstream juvenile passage at dam

Assumptions:

Most of river harvest is on half-pounders, produced above but harvested below SRD. Source: ODFW, 1994, p.189
(Does not include adult returns from half-pounders to avoid double counting).
SRD adult and half-pounder equivalent loss existing conditions (low range) =2,650 Source: Burchfield et al, 1994, Table 10
SRD juvenile mortality = 5%(juveniles migrating to SRD) Source: Young, 1995 (estimated range 0-5%)
Hatchery juvenile-to-half-pounder survival rate = 12% Source: ODFW, 1994
Hatchery juvenile-to-adult survival rate = 1.2% Source: ODFW, hatchery data, (average, 1974-86 brood years)
Hatchery juveniles released = 121,000 Source: ODFW,1990,p.68, 1976-86 average, Rogue stock only
(Current release target = 150,000) Source: ODFW, hatchery release data, 1989-94
Juveniles migrating to SRD = 80%(Juveniles released each year) Source: Evenson, personal communication, estimate
Hatchery adults = 23% of total population passing Gold Ray Dam Source: ODFW,1990, p.32, 1979-87 average
Hatchery adults = 0.23(9,317) = 2,143
Hatchery adults = (2,143)/(13,373) = 16% of total adults passing Savage Rapids Dam
Wild adults passing Savage Rapids Dam = Total upper river escapement - Hatchery adults = 13,373 - 2,143 = 11,230
Half-pounder return to river = 70% of total adult + half-pounder return Source: ODFW, 1990,p.44, Angler catch, middle river, 1978/79 and 1979/80
(Adult return = 30% of total returns)
Half-pounder equivalent loss with dam ret. alt. = 70%(SRD juvenile mortality)(Juvenile-to-half-pounder survival rate)
Adult equivalent loss with dam ret. alt. = 30%(SRD juvenile mortality)(Juvenile-to-adult survival rate)

Calculations:

Hatchery juveniles migrating to SRD = 0.80(121,000) = 96,800
SRD hatchery fish juvenile mortality = 0.05(96,800) = 4,840
Half-pounder equivalent loss hatchery fish with dam ret. alt. = 0.70 (4,840)(0.12) = 407
Half-pounder equiv. loss wild + hatchery fish = half-pounder equiv. loss hatch. fish/percentage of hatchery adults of total passing SRD
Half-pounder equiv. loss wild + hatchery fish = (407)/(0.16) = 2,544
Half-pounder equiv. loss wild fish = 2,544 - 407 = 2,137

Adult equivalent loss of hatchery fish = 0.30(4,840)(0.012) = 17
Adult equiv. loss of wild + hatchery fish = (17)/(0.16) = 106
Adult equiv. loss wild fish = 106 - 17 = 89
Total adult and half-pounder equiv. loss of wild and hatchery fish = 2,544 + 106 = 2,650
Adult and half-pounder equivalent increase = Adult and half-pounder equiv. loss existing conditions
- adult and half-pounder equiv. loss with dam ret. alt.
2,650 - 2,650 = 0 =Adult and half-pounder equiv. increase (downstream passage) with dam ret. alternative

Total Winter Steelhead Increase		Upstream Passage		Adult and Half-pounder Equiv. Downstream Passage
1,072	=	1,072	+	0

Table 5. Estimated Coho Salmon Increases Resulting from Savage Rapids Range Dam Retention and Improvement Alternative - Low Range

Upstream adult passage at dam

Assumptions:

SRD adult loss existing conditions (low range) = 220	Source: Burchfield et al, 1994, Table 11
SRD adult loss with dam ret. alt. =3%(Adults at base of SRD)	Source: Young, 1995 (estimated range 0-3% adult passage loss)
Gold Ray Dam counts = 1,981	Source: Gold Ray Dam counts, 1942 - 93, average

Assume no wild fish spawning between Gold Ray and Savage Rapids dams

Upper river escapement = Gold Ray Dam counts = 0.97(Adults at base of SRD)

Calculations:

Adults at base of SRD = Upper river escapement/(0.97) = 1,981/(0.97) = 2,042

SRD adult passage loss with dam ret. alt. = 0.03(2,042) = 61

Adult increase = Adult loss under existing conditions - adult loss expected with dam retention alternative

= 220 - 61 = 159 =Adult increase (upstream passage) with dam retention alternative

Downstream juvenile passage at dam

Assumptions:

SRD adult equivalent loss existing conditions (low range) = 160	Source: Burchfield et al, 1994, Table 11
SRD juvenile mortality = 5%(juveniles migrating to SRD)	Source: Young, 1995 (estimated range 0-5%)
Hatchery juvenile-to-adult survival rate = 2%	Source: Lewis, 1993 Average 1977-89 brood years,range 0.3-12%
Hatchery juveniles released = 200,000	Source: ODFW, hatchery release data, 1985-94

(Juveniles produced each year)(Juvenile-to-adult survival) = Hatchery Adults produced (includes ocean harvest)

Juveniles migrating to SRD = 80%(Juveniles produced each year)	Source: Evenson, personal communication, estimate

Adult equivalent loss with dam ret. alt. = (SRD juvenile mortality)(Juvenile-to-adult survival rate)

Calculations:

Juveniles migrating to SRD = 0.80(200,000) = 160,000

SRD juvenile mortality = 0.05(160,000) = 8,000

Adult equivalent loss with dam ret. alt. = (8,000)(0.02) = 160

Adult equivalent increase = Adult equiv. loss existing conditions - adult equiv. loss with dam ret. alt.

= 160 - 160 = 0 =Adult equiv. increase (downstream passage) with dam retention alternative

Total Hatchery Coho Increase		Upstream Passage		Adult Equiv. Downstream Passage
159	=	159	+	0

Table 6. Estimated Salmon and Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - Low Range

(Adults or adult equivalents contributing to ocean harvest, river harvest, and spawning)

Species	Upstream Passage	Downstream Passage	Spawning Habitat Increase	Total
Spring Chinook	2,495	0	0	2,495
Fall Chinook	1,002	0	0	1,002
Summer Steelhead	773	14	0	787
Winter Steelhead	1,072	0	0	1,072
Coho (hatchery fish only)	159	0	0	159
			Grand Total =	5,515

Table 7. Estimated Spring Chinook Salmon Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - High Range

Adult Production = Upper river (UR) returns + River harvest + Ocean harvest

Assumptions:

UR returns =	31,126	Source: Gold Ray Dam counts, 1942 - 93 average
Lower river harvest rate =	28%	Source: Cramer et al, 1985, p. 255 (1964-81); does not include jacks
Ocean harvest =	43,397	Source: Satterthwaite, 1987, p.27, Table 9; catch:escapement = 1:1

Calculations:

River harvest = 0.28(Total fish at mouth) = 0.28(UR return + River harvest) = 0.28 (UR return)/(1-0.28)

River harvest = 0.28(31,126)/0.72 = 12, 105

Upper R. Returns	+ River Harvest	+ Ocean Harvest =	Adult Production
31,126	12,105	43,397	86,628

Upstream adult passage at dam

Assumptions:

SRD adult loss existing conditions (high range) = 13,340 — Source: Burchfield et al, 1994, Table 13

SRD adult loss with dam ret. alt. = 0%(Adults at base of SRD) — Source: Young, 1995 (estimated range 0-3% adult passage loss)

Assume no loss between Savage Rapids (SRD) and Gold Ray (GRD) dams

Calculations:

Adults at base of SRD = GRD counts + SRD Upstream Loss = GRD counts + 0.00(Adults at base of SRD)

(Adults at base of SRD) = GRD counts

Adults at base of SRD = GRD counts = 31,126

Adults at base of SRD	x SRD adult loss rate =	Adult loss with dam retention alternative
31,126	0%	0

Adult increase = Adult loss under existing conditions - adult loss expected with dam retention alternative

= 13,340 - 0 = 13,340 = Adult increase (upstream passage) with dam retention alternative

Downstream juvenile passage at dam

Assumptions:

SRD adult equivalent loss existing conditions (high range) = 17,208	Source: Burchfield et al, 1994, Table 13
SRD juvenile mortality = 0%(smolts migrating to SRD)	Source: Young, 1995 (estimated range 0-5%)
Hatchery smolts produced = 1,458,000	Source: ODFW, hatchery release data, 1986-94
Wild smolts produced = 1,410,000	Source: ODFW unpublished data, mean for 1976-90
Hatchery smolt-to-adult survival rate = 2%	Source: ODFW, hatchery data, includes harvest
Wild smolt-to-adult survival rate = 2%	Source: Satterthwaite, 1994, personal communication.

Table 7, continued. Estimated Spring Chinook Salmon Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - High Range

Downstream juvenile passage at dam, continued

Calculations:

SRD juvenile loss (hatchery) = 0%(1,458,000) = 0

SRD juvenile loss (wild) = 0%(1,410,000) = 0

Adult equivalent loss with dam ret. alt = (SRD hatchery juvenile loss x hatchery smolt-to-adult survival rate) + (SRD wild juvenile loss x wild smolt-to-adult survival rate) = (0 x 0.02) + (0 x 0.02) = 0

Adult equivalent increase = Adult equiv. loss existing conditions - adult equiv. loss with dam ret. alt.

= 17,208 - 0 = 17,208 =Adult equiv. increase (downstream passage) with dam retention alternative

Total Spring Chinook Increase		Upstream Passage		Adult Equiv. Downstream Passage
30,548	=	13,340	+	17,208

Table 8. Estimated Fall Chinook Salmon Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - High Range

Above Savage Rapids Adult Production = Upper river run at mouth + Ocean harvest of fish originating above SRD

Assumptions:

Upper river run at mouth = Spawning escapement + River harvest + lower river prespawning mortality

Spawning escapement = Gold Ray Dam counts + Spawning between SRD and GRD

Gold Ray Dam counts = 3,148 Source: Gold Ray Dam counts, 1942 - 93 average

Spawning between SRD and GRD = 9,350 Source: Satterthwaite, 1992 (500 fish/km)

River harvest = 9.5% (upper river run at mouth) Source: ODFW, 1992, p.78, 1974-86 average

Prespawning mortality = 20%(upper river run at mouth) Source: Satterthwaite, personal communication

Ocean harvest = 2(upper river run at mouth) Source: Satterthwaite, personal communication, assume C:E = 2:1 for upper river fall chinook

Calculations:

Spawning escapement = 3,148 + 9,350 = 12,498

Upper river run at mouth = 12,498 + 0.095(upper run) +0.20(upper run)

Upper run(1-0.095-0.20) = 12,498

Upper run = 12,498/0.70 = 17,728

River harvest = (0.095)(17,728) = 1,684

Prespawning mortality = (0.20)(17,728) = 3,546

Ocean harvest = 2(17,728) = 35,456

Above Savage Rapids Adult Production = 17,728 + 35,456 = 53,184

Table 8, continued. Estimated Fall Chinook Salmon Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - High Range

Upstream adult passage at dam

Assumptions:

SRD adult passage loss existing conditions (high range) =5,356 — Source: Burchfield et al, 1994, Table 14

SRD adult loss with dam ret. alt.=0%(Adults at base of SRD) — Source: Young, 1995 (estimated range 0-3% adult passage loss)

Spawning escapement = Gold Ray Dam counts + Spawning between SRD and GRD = 12,498

Spawning escapement = Adults at base of SRD

Calculations:

Adults at base of SRD = Spawning escapement = 12,498

SRD adult passage loss with dam ret. alt. = 0.0(12,498) = 0

Adult increase = Adult loss under existing conditions - adult loss expected with dam retention alternative

= 5,356 - 0 = 5,356 =Adult increase (upstream passage) with dam retention alternative

Downstream juvenile passage at dam

Assumptions:

SRD adult equivalent loss existing conditions (high range) = 5,318 — Source: Burchfield et al, 1994, Table 14

SRD juvenile mortality = 0%(juveniles migrating to SRD) — Source: Young, 1995 (estimated range 0-5%)

Wild juvenile-to-adult survival rate = 2% — Source: ODFW unpublished data, 1976-90 average

(Juveniles produced each year)(Juvenile-to-adult survival rate) = Upper river adult run at mouth

Adult equivalent loss with dam ret. alt. = (SRD juvenile mortality)(Juvenile-to-adult survival rate)

Calculations:

Juveniles produced = Upper river adult run at mouth/juvenile-to-adult survival rate = 17,728/0.02

Juveniles produced = 886,400

SRD juvenile mortality = 0.0(886,400) = 0

Adult equivalent loss with dam ret. alt. = (0)(0.02) = 0

Adult equivalent increase = Adult equiv. loss existing conditions - adult equiv. loss with dam ret. alt.

= 5,318 - 0 = 5,318 =Adult equiv. increase (downstream passage) with dam ret. alternative

Total Fall Chinook Increase		Upstream Passage		Adult Equiv. Downstream Passage
10,674	=	5,356	+	5,318

Table 9. Estimated Summer Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - High Range

Upstream adult passage at dam

Assumptions:

SRD adult loss existing conditions (high range) = 4,131	Source: Burchfield et al, 1994, Table 15
SRD adult loss with dam ret. alt. = 0% (Adults at base of SRD)	Source: Young, 1995 (estimated range 0-3% adult passage loss)
Gold Ray Dam counts = 6,016	Source: Gold Ray Dam counts, 1942 - 93, average
Returns between Gold Ray and Savage Rapids dams = 3624	Source: Satterthwaite, 1992

Upper river escapement = Gold Ray Dam Counts + Returns between Gold Ray and Savage Rapids

Upper river escapement = Adults at base of SRD

Calculations:

Upper river escapement = 6,016 + 3,624 = 9640

Adults at base of SRD = Upper river escapement = 9,640

SRD adult passage loss with dam ret. alt. = 0.0(9,640) = 0

Adult increase = Adult loss under existing conditions - adult loss expected with dam retention alternative

= 4,131 - 0 = 4,131 = Adult increase (upstream passage) with dam retention alternative

Downstream juvenile passage at dam

Assumptions:

Most of river harvest is on half-pounders, produced above but harvested below SRD. Source: ODFW, 1994, p.189

(Does not include adult returns from half-pounders to avoid double counting).

SRD half-pounder equivalent loss existing conditions (high range) = 21,566	Source: Burchfield et al, 1994, Table 15
SRD juvenile mortality = 0% (juveniles migrating to SRD)	Source: Young, 1995 (estimated range 0-5%)
Hatchery juvenile-to-half-pounder survival rate = 12%	Source: ODFW, 1994, p.1, range = 3 - 28%, 1976-91 returns
Hatchery juveniles released = 144,523	Source: ODFW, 1994, p.134, 1974-91 average
(Current releases = 220,000)	Source: ODFW, hatchery release data, 1991-94
Juveniles migrating to SRD = 80% (Juveniles released each year)	Source: Evenson, personal communication, estimate

Half-pounder equivalent loss with dam ret. alt = (SRD juvenile mortality)(Juvenile-to-half-pounder survival rate)

Hatchery adults = 31% of total population passing Gold Ray Dam Source: ODFW, 1994, p.51, 1970-91 brood years

Hatchery adults = 0.31(6,016) = 1,865

Hatchery adults = (1,865)/(9,640) = 19.3% of total adults passing Savage Rapids Dam

Table 9, continued. Estimated Summer Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - High Range

Calculations:

Hatchery juveniles migrating to SRD = 0.80(144,523) = 115,618
SRD hatchery fish juvenile mortality = 0.0(115,168) = 0
Half-pounder equivalent loss hatchery fish with dam ret. alt. = (0)(0.12) = 0
Half-pounder equiv. loss wild + hatchery fish = half-pounder equiv. loss hatch. fish/percentage of hatchery adults of total passing SRD
Half-pounder equiv. loss wild + hatchery fish = (0)/(0.193) = 0
Half-pounder equiv. loss wild fish = 0 - 0 = 0
Half-pounder equivalent increase = Half-pounder equiv. loss existing conditions - half-pounder equiv. loss with dam ret. alt.
= 21,566 - 0 = 21,566 =Half-pounder equiv. increase (downstream passage) with dam retention alternative

Total Summer Steelhead Increase		Upstream Passage		Half-pounder Equiv. Downstream Passage
25,697	=	4,131	+	21,566

Table 10. Estimated Winter Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - High Range

Upstream adult passage at dam

Assumptions:

SRD adult loss existing conditions (high range) =5,731 — Source: Burchfield et al, 1994, Table 16
SRD adult loss with dam ret. alt.= 0%(Adults at base of SRD) — Source: Young, 1995 (estimated range 0-3% adult passage loss)
Gold Ray Dam counts = 9,317 — Source: Gold Ray Dam counts, 1942 - 93, average
Returns between Gold Ray and Savage Rapids dams = 4056 — Source: Satterthwaite, 1992
Upper river escapement = Gold Ray Dam counts + Returns between Gold Ray and Savage Rapids
Upper river escapement = 9,317 + 4,056 = 13,373
Upper river escapement = Adults at base of SRD

Calculations:

Adults at base of SRD = Upper river escapement = 13,373
SRD adult passage loss with dam ret. alt. = 0.0(13,373) = 0
Adult increase = Adult loss under existing conditions - adult loss expected with dam retention alternative
= 5,731 - 0 = 5,731 =Adult increase (upstream passage) with dam retention alternative

Table 10, continued. Estimated Winter Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - High Range

Downstream juvenile passage at dam

Assumptions:

Most of river harvest is on half-pounders, produced above but harvested below SRD. Source: ODFW, 1994, p.189
(Does not include adult returns from half-pounders to avoid double counting).
SRD adult and half-pounder equivalent loss existing conditions (high range) =15,899 Source: Burchfield et al, 1994, Table 16
SRD juvenile mortality = 0%(juveniles migrating to SRD) Source: Young, 1995 (estimated range 0-5%)
Hatchery juvenile-to-half-pounder survival rate = 12% Source: ODFW, 1994
Hatchery juvenile-to-adult survival rate = 1.2% Source: ODFW, hatchery data, (average, 1974-86 brood years)
Hatchery juveniles released = 121,000 Source: ODFW,1990,p.68, 1976-86 average, Rogue stock only
(Current release target = 150,000) Source: ODFW, hatchery release data, 1989-94
Juveniles migrating to SRD = 80%(Juveniles released each year) Source: Evenson, personal communication, estimate
Hatchery adults = 23% of total population passing Gold Ray Dam Source: ODFW,1990, p.32, 1979-87 average
Hatchery adults = 0.23(9,317) = 2,143
Hatchery adults = (2,143)/(13,373) = 16% of total adults passing Savage Rapids Dam
Wild adults passing Savage Rapids Dam = Total upper river escapement - Hatchery adults = 13,373 - 2,143 = 11,230
Half-pounder return to river = 70% of total adult + half-pounder return Source: ODFW, 1990,p.44, Angler catch, middle river, 1978/79 and 1979/80
(Adult return = 30% of total returns)
Half-pounder equivalent loss with dam ret. alt. = 70%(SRD juvenile mortality)(Juvenile-to-half-pounder survival rate)
Adult equivalent loss with dam ret. alt. = 30%(SRD juvenile mortality)(Juvenile-to-adult survival rate)

Calculations:

Hatchery juveniles migrating to SRD = 0.80(121,000) = 96,800
SRD hatchery fish juvenile mortality = 0.0(96,800) = 0
Half-pounder equivalent loss hatchery fish with dam ret. alt. = 0.70 (0)(0.12) = 0
Half-pounder equiv. loss wild + hatchery fish = half-pounder equiv. loss hatch. fish/percentage of hatchery adults of total passing SRD
Half-pounder equiv. loss wild + hatchery fish = (0)/(0.16) = 0
Half-pounder equiv. loss wild fish = 0 - 0 = 0

Adult equivalent loss of hatchery fish = 0.30(0)(0.012) = 0
Adult equiv. loss of wild + hatchery fish = (0)/(0.16) = 0
Adult equiv. loss wild fish = 0 - 0 = 0
Total adult and half-pounder equiv. loss of wild and hatchery fish = 0 + 0 = 0
Adult and half-pounder equivalent increase = Adult and half-pounder equiv. loss existing conditions
- adult and half-pounder equiv. loss with dam ret. alt.
15,899 - 0 = 15,899 =Adult and half-pounder equiv. increase (downstream passage) with dam ret. alternative

Total Winter Steelhead Increase	Upstream Passage		Adult and Half-pounder Equiv. Downstream Passage
21,630 =	5,731	+	15,899

Table 11. Estimated Coho Salmon Increases Resulting from Savage Rapids Range Dam Retention and Improvement Alternative - High Range

Upstream adult passage at dam

Assumptions:

SRD adult loss existing conditions (high range) = 849 — Source: Burchfield et al, 1994, Table 17

SRD adult loss with dam ret. alt. = 0%(Adults at base of SRD) — Source: Young, 1995 (estimated range 0-3% adult passage loss)

Gold Ray Dam counts = 1,981 — Source: Gold Ray Dam counts, 1942 - 93, average

Assume no wild fish spawning between Gold Ray and Savage Rapids dams

Upper river escapement = Gold Ray Dam counts = Adults at base of SRD

Calculations:

Adults at base of SRD = Upper river escapement = 1,981

SRD adult passage loss with dam ret. alt. = 0.0(1,981) = 0

Adult increase = Adult loss under existing conditions - adult loss expected with dam retention alternative

= 849 - 0 = 849 =Adult increase (upstream passage) with dam retention alternative

Downstream juvenile passage at dam

Assumptions:

SRD adult equivalent loss existing conditions (high range) = 960 — Source: Burchfield et al, 1994, Table 17

SRD juvenile mortality = 0%(juveniles migrating to SRD) — Source: Young, 1995 (estimated range 0-5%)

Hatchery juvenile-to-adult survival rate = 2% — Source: Lewis, 1993 Average 1977-89 brood years, range 0.3-12%

Hatchery juveniles released = 200,000 — Source: ODFW, hatchery release data, 1985-94

(Juveniles produced each year)(Juvenile-to-adult survival) = Hatchery Adults produced (includes ocean harvest)

Juveniles migrating to SRD = 80%(Juveniles produced each year) — Source: Evenson, personal communication, estimate

Adult equivalent loss with dam ret. alt. = (SRD juvenile mortality)(Juvenile-to-adult survival rate)

Calculations:

Juveniles migrating to SRD = 0.80(200,000) = 160,000

SRD juvenile mortality = 0.0(160,000) = 0

Adult equivalent loss with dam ret. alt. = (0)(0.02) = 0

Adult equivalent increase = Adult equiv. loss existing conditions - adult equiv. loss with dam ret. alt.

= 960 - 0 = 960 =Adult equiv. increase (downstream passage) with dam retention alternative

Total Hatchery Coho Increase		Upstream Passage		Adult Equiv. Downstream Passage
1,809	=	849	+	960

Table 12. Estimated Salmon and Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative - High Range

(Adults or adult equivalents contributing to ocean harvest, river harvest, and spawning)

Species	Upstream Passage	Downstream Passage	Spawning Habitat Increase	Total
Spring Chinook	13,340	17,208	0	30,548
Fall Chinook	5,356	5,318	0	10,674
Summer Steelhead	4,131	21,566	0	25,697
Winter Steelhead	5,731	15,899	0	21,630
Coho (hatchery fish only)	849	960	0	1,809
			Grand Total =	**90,358**

Table 13. Summary of Estimated Salmon and Steelhead Increases Resulting from Savage Rapids Dam Retention and Improvement Alternative

(Adults or adult equivalents contributing to ocean harvest, river harvest, and spawning)

Species	Low Range	High Range
Spring Chinook	2,495	30,548
Fall Chinook	1,002	10,674
Summer Steelhead	787	25,697
Winter Steelhead	1,072	21,630
Coho (hatchery fish only)	159	1,809
Totals:	5,515	90,358

Figure 1. Potential Increased Salmon and Steelhead Returns for Harvest and Spawning resulting from Savage Rapids Dam Retention and Improvement Alternative

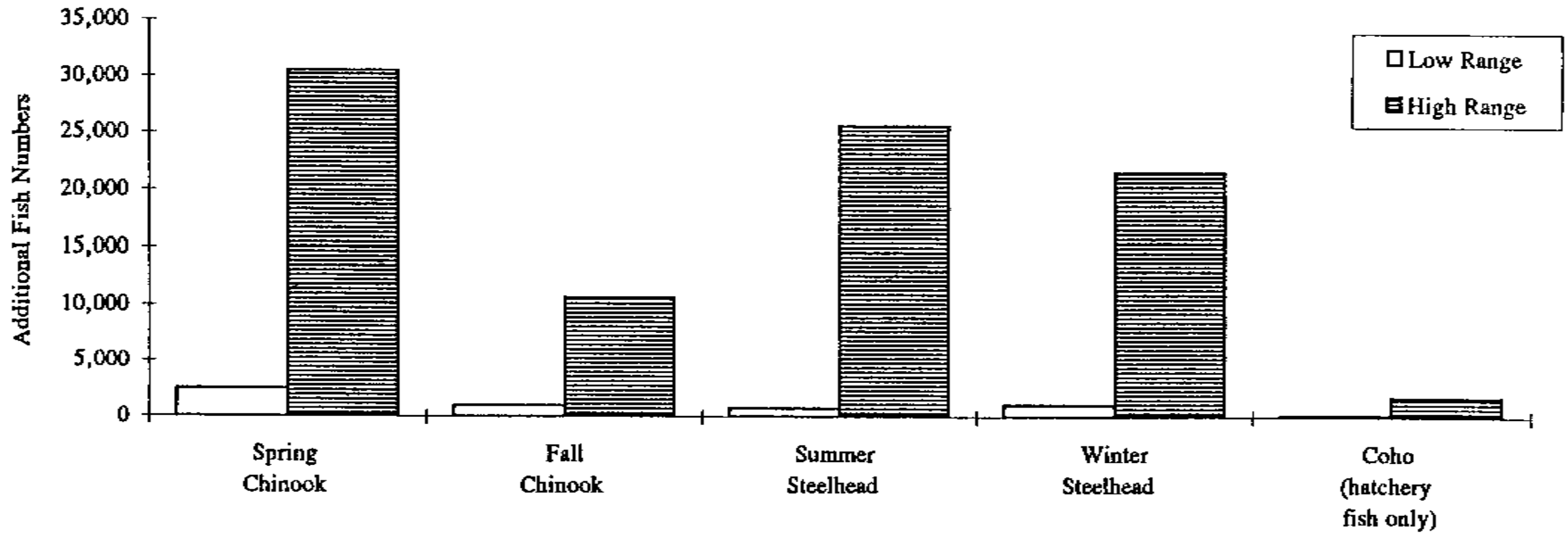
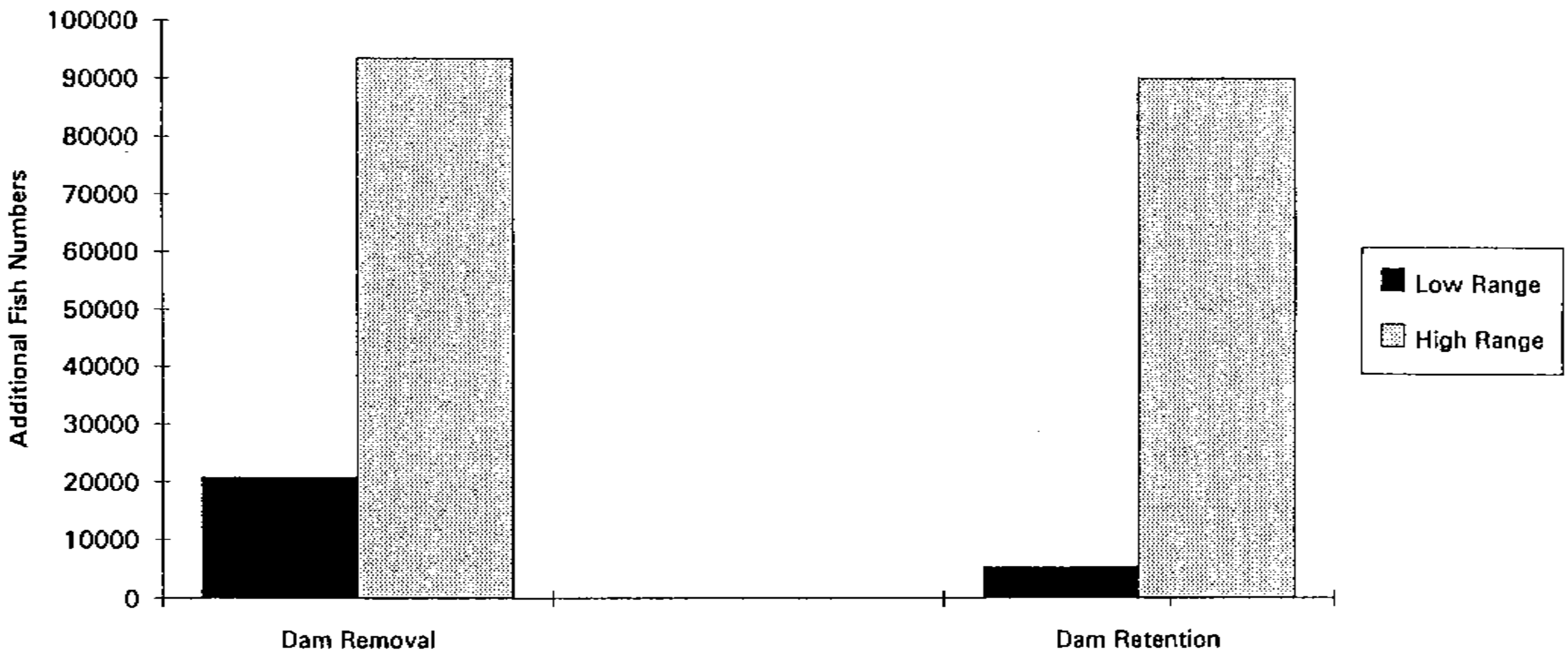


Figure 2. Total Potential Increased Salmon and Steelhead Returns for Harvest and Spawning Expected from Two Alternatives for Savage Rapids Dam: Dam Removal and Dam Alternative



ESTIMATION OF ROGUE RIVER SALMON AND STEELHEAD POPULATION INCREASES FOR THE SAVAGE RAPIDS "DAM REMOVAL" OPTION

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Background

This report presents estimates of potential Rogue River salmon and steelhead population increases that would be expected if Savage Rapids Dam were removed. These estimates are based upon Oregon Department of Fish and Wildlife's (ODFW) most recent effort to model fish mortality associated with the dam. The assessment incorporates updated information concerning the life history and abundance of anadromous fish species that migrate past the dam.

In 1979 the National Marine Fisheries Service (NMFS) conducted an analysis which concluded that upstream and downstream passage problems at Savage Rapids Dam, as well as loss of fall chinook spawning habitat by reservoir inundation, caused significant losses of Rogue Basin salmon and steelhead (NMFS 1979). The NMFS estimated that if these problems were corrected, the populations would increase annually by 26,700 adult fish as measured at the dam.

In the course of recent discussions concerning the conditions of a temporary water right for the Grants Pass Irrigation District, many people have stated that the NMFS fish loss estimates may be outdated and no longer applicable. Because of the controversy surrounding the NMFS estimate, ODFW staff biologists were asked to review current information and make an independent estimate of potential increases in salmon and steelhead populations if the effects of the dam were eliminated by addition of state-of-the-art fishways and screens or by dam removal.

The following analysis makes use of the best techniques for mathematically predicting population increases given changes at the dam site. These techniques allow rapid and accurate estimates of the population numbers we seek, but without the great expense of extended and time-consuming analysis. Project applicants often legitimately complain about the time and expense of environmental evaluations that frequently yield information only slightly more reliable than can be predicted by the mathematical techniques used in this study. By this technique ODFW biologists are able to compute the lowest possible level of fish loss caused by

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the facility, as well as the highest level reasonably possible. These high and low estimates are based on generally accepted averages for fish losses derived from studies at dams and water diversions of all possible configurations.

The high and low estimates are used to set the reasonable boundaries, within which the actual population number will lie. Biologists also computed an average estimate which falls within this range. However, because a number of factors influence this number from year to year, the actual population number will vary yearly, but this variation is expected to fall within the high and low boundaries discussed above.

In making a comparison with the NMFS estimate, this technique will tell whether the NMFS estimate was reasonable, because it falls within the estimated range, or will tell if the NMFS estimate was unreasonable, because it falls outside the range of reasonable possibility. For making general decisions, this technique offers quick and accurate results, as well as a wide range within which the actual population numbers will lie. This technique is particularly appropriate for making general estimates of numbers that tend to change from year to year, as do the fish populations at issue here, for example due to factors such as changing ocean and harvest conditions. While great expense and time could be expended to refine the estimate, this only would better home in on a number that would lie somewhere within the range of numbers already predicted by this study, and a number that can change from year to year anyway.

The estimates in this study are based on dam removal. We are in the process of conducting a similar analysis that is based on retrofitting the facility with state-of-the-art fishways, screens, and other modern-day technology to pass fish. While this analysis is not yet complete, such retrofit of the dam will yield somewhat less protection to fish than complete dam removal, because even the best designed fishway of today impedes fish passage to some degree. However, improvements in fish passage using modern technology will offer a significant advantage to fisheries over the current situation.

<u>Approach</u>

Upstream and downstream mortality estimates were assumed similar to generally accepted standards for such mortality as determined through experimental methodology at other dams. In making estimates for the Savage Rapids Dam, present design of the fishway, screens, and spillway and the operating condition of the facilities were taken into account (Franklin Young, July 1994; see attached memo). The fishways are old and designed to engineering standards no longer considered effective for fish passage. Fish facilities at this dam do not meet current design criteria used by ODFW, NMFS and the U.S. Fish and Wildlife Service (USFWS). Low, mid, and high estimates were made in order to bracket the likely range in juvenile and adult passage mortality at Savage Rapids Dam.

Our estimates state the results in terms of additional adult fish passing the dam site, <u>plus</u> contributions to downstream and ocean fisheries. Although the NMFS estimate of 26,700 fish did not include harvest impacts, a subsequent analysis by USFWS predicted that 87,900 additional fish could be harvested based on an increased escapement of 26,700 (USFWS 1990). Adding the NMFS and USFWS estimates results in a total of 114,600 additional fish. Our estimates are generally higher than the NMFS estimate yet lower than the total NMFS and USFWS estimates.

During low return cycles ocean and river harvests are heavily restricted, thus the ratio between the number of fish harvested and those fish escaping to spawn varies over the years. In general, Rogue salmon and steelhead fisheries have been curtailed in recent years to reduce harvest on specific populations in the lower river and in other coastal basins. Therefore, ODFW used lower harvest rates than the USFWS used in its assessments of harvest impacts in order to better reflect current conditions. This explains why ODFW's range of estimates is less than the total USFWS and NMFS estimates of 114,600 additional fish for harvest and escapement.

"Half-pounder" steelhead in the Rogue River are immature steelhead that typically enter the ocean in the spring, reside there three to five months, return to freshwater, and reside in the lower portions of the Rogue River for five to seven months, prior to returning to the ocean. This is a major component of Rogue River steelhead fisheries. While most "half-pounders" generally do not get as far upstream as Savage Rapids Dam, they make a significant contribution to downstream sport fisheries. Because juvenile steelhead production above Savage Rapids Dam contributes to this fishery, the potential increase in harvestable fish resulting from juvenile losses at the dam is accounted for in this assessment.

Details and calculations associated with ODFW's estimate are contained in the attached tables 1 through 19.

<u>Results</u>

Tables 1 through 5 show the assumptions and calculations that were made to estimate annual increases in harvest and spawning populations of spring chinook, fall chinook, summer steelhead, winter steelhead, and coho salmon. These increases, termed "mid range" estimates, use an average upstream fish mortality rate of 15% and an average downstream fish mortality rate of 15%. These estimates fall between the "low" and "high" estimates that will be discussed below. The numbers represent potential increased production of adult fish in the Rogue River if the following fish impacts at Savage Rapids Dam were eliminated: juvenile fish injury and mortality during the downstream migration, adult fish injury, mortality and delay during the upstream migration, and lost spawning opportunities associated with reservoir inundation of historic and potential habitat. The tables cite sources of data and assumptions used in the mathematical computations. The "Literature Cited" section provides full reference information for these sources.

Table 6 is a summary table that lists "mid range" estimates for each species. Based on the assumptions in this model, we estimate that an additional 43,620 salmon and steelhead would be produced annually if Savage Rapids Dam were removed.

Tables 7 through 11 represent "low range" estimates of additional salmon and steelhead production based on upstream and downstream mortality rates at Savage Rapids Dam of 10 and 5 percent, respectively. Table 12 summarizes the "low range" estimates for each species, and shows a combined "low range" estimate for all species of 20,865.

Tables 13 through 17 represent "high range" estimates of additional salmon and steelhead production attributable to Savage Rapids Dam. These tables use the same mathematical model as that shown in detail in tables 1 through 5; however, mortality rates at the dam represent the high end loss estimates of 30 percent for both juvenile and adult passage. Table 18 summarizes the "high range" estimates for each species, and shows a combined estimate of 93,542 for all species.

Table 19 summarizes previous tables and shows the range of additional production for each species. Figure 1 shows this information for each species in graphical form. For all species combined, our estimates range from a low of 20,865 to a high of 93,542, with a mid-range estimate of 43,620 as shown in Figure 2.

Conclusions

The range of numbers obtained, 20,865 to 93,542 fish annually, represents a reasonable range of estimates for expected salmon and steelhead population increases attributable to Savage Rapids Dam removal. As stated above, actual increases will vary yearly, and are highly dependent on run sizes and harvest rates. Coho salmon estimates are primarily based on hatchery fish numbers, and the effects on naturally produced coho are not considered. Potential listing of coho under the federal Endangered Species Act would make such a calculation meaningless, because when populations are listed as either threatened or endangered, the value of each individual fish to recovery efforts becomes significantly higher than its harvestable value.

Two alternatives to correct fish passage problems at the dam are under consideration: dam removal and dam retention with modifications. The calculations in the tables assume that the current loss rates would be reduced to virtually zero in order to produce the estimated fish benefits. These calculations are most representative of the "dam removal" option. The "dam retention" alternative, in which state-of-the-art fish passage facilities would be installed, would significantly reduce existing fish passage mortalities, although some losses of juvenile and adult fish would continue at the dam, and fall chinook salmon spawning habitat in the reservoir area would remain unavailable. We currently are making a series of computations that would provide a reasonable range of population increases expected with improvements at the dam.

The model that we developed predicts population increases in the same range as the NMFS' 1979 estimate of 26,700. As described above, the NMFS analysis estimated potential increased adult fish returns to the dam and did not include harvest increases. The USFWS' 1990 analysis concluded that an increased escapement potential of 26,700 adult fish passing Savage Rapids Dam represents an additional increase of 87,900 fish to commercial and sport harvest (USFWS 1990). Hence, using the NMFS and USFWS estimates, approximately

114,600 additional adult fish could be produced annually if Savage Rapids Dam were removed. This total estimate is greater than the high range estimate predicted in our model. The reason for this discrepancy is that run sizes and harvest rates were higher during the years in which USFWS based its analysis than they are today. If run sizes and harvest rates increase in future years, we would expect total fish population increases attributable to Savage Rapids Dam removal to more closely approximate the 114,600 estimate than our range of 20,865 to 93,542.

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Table 1. Estimated Spring Chinook Salmon Increases Resulting from Savage Rapids Dam Removal - Mid Range

Adult Production = Upper river (UR) returns + River harvest + Ocean harvest

Assumptions:

UR returns =	31,126	Source: Gold Ray Dam counts, 1942 - 93 average
Lower river harvest rate =	28%	Source: Cramer et al, 1985, p. 255 (1964-81); does not include jacks
Ocean harvest =	43,397	Source: Satterthwaite, 1987, p.27, Table 9; catch:escapement = 1:1

Calculations:

River harvest = 0.28(Total fish at mouth) = 0.28(UR return + River harvest) = 0.28 (UR return)/(1-0.28)

River harvest = 0.28(31,126)/0.72 = 12, 105

Upper R. Returns	+ River Harvest	+ Ocean Harvest =	Adult Production
31,126	12,105	43,397	86,628

Upstream adult passage at dam

Assumptions:

SRD adult upstream mortality = 15%(Adults at base of SRD) Source: Young, 1994 (estimated range 10-30% adult passage loss)

Assume no loss between Savage Rapid (SRD) and Gold Ray (GRD) dams

Calculations:

Adults at base of SRD = GRD counts + SRD Upstream Loss = GRD counts + 0.15(Adults at base of SRD)

0.85(Adults at base of SRD) = GRD counts

Adults at base of SRD = GRD counts/0.85 = 31,126/0.85 = 36,619

Adults at base of SRD x SRD adult mortality rate =

36,619 15%

Adult increase due to eliminating SRD adult passage loss
5,493

Downstream juvenile passage at dam

Assumptions:

SRD juvenile mortality = 15%(smolts migrating to SRD)	Source: Young, 1994 (estimated average 10-15%, and range 5-30%)
Hatchery smolts produced = 1,458,000	Source: ODFW, hatchery release data, 1986-94
Wild smolts produced = 1,410,000	Source: ODFW unpublished data, mean for 1976-90
Hatchery smolt-to-adult survival rate = 2%	Source: ODFW, hatchery data, includes harvest
Wild smolt-to-adult survival rate = 2%	Source: Satterthwaite, 1994, personal communication.

Calculations:

SRD juvenile loss (hatchery) = 15%(1,458,000) = 218,700

SRD juvenile loss (wild) = 15%(1,410,000) = 211,500

Adult equivalent increase due to eliminating SRD downstream loss = (SRD hatchery juvenile loss x hatchery smolt-to-adult survival rate) + (SRD wild juvenile loss x wild smolt-to-adult survival rate) = (218,700 x 0.02) + (211,500 x 0.02) = 8,604

Adult equivalent increase due to eliminating SRD downstream loss = 8,604

Total Spring Chinook Increase		Upstream Passage		Adult Equiv. Downstream Passage
14,097	=	5,493	+	8,604

Table 2. Estimated Fall Chinook Salmon Increases Resulting from Savage Rapids Dam Removal - Mid Range

Above Savage Rapids Adult Production = Upper river run at mouth + Ocean harvest of fish originating above SRD

Assumptions:

Upper river run at mouth = Spawning escapement + River harvest + lower river prespawning mortality

Spawning escapement = Gold Ray Dam counts + Spawning between SRD and GRD

Gold Ray Dam counts = 3,148 Source: Gold Ray Dam counts, 1942 - 93 average

Spawning between SRD and GRD = 9,350 Source: Satterthwaite, 1992 (500 fish/km)

River harvest = 9.5% (upper river run at mouth) Source: ODFW, 1992, p.78, 1974-86 average

Prespawning mortality = 20%(upper river run at mouth) Source: Satterthwaite, personal communication

Ocean harvest = 2(upper river run at mouth) Source: Satterthwaite, personal communication, assume C:E = 2:1 for upper river fall chinook

Calculations:

Spawning escapement = 3,148 + 9,350 = 12,498

Upper river run at mouth = 12,498 + 0.095(upper run) + 0.20(upper run)

Upper run(1-0.095-0.20) = 12,498

Upper run = 12,498/0.70 = 17,728

River harvest = (0.095)(17,728) = 1,684

Prespawning mortality = (0.20)(17,728) = 3,546

Ocean harvest = 2(17,728) = 35,456

Above Savage Rapids Adult Production = 17,728 + 35,456 = 53,184

Adult spawning habitat increases

Loss of spawning potential = Potential adults that would spawn in channel inundated by SRD reservoir and below SRD

Assumptions:

Potential adults spawning in channel inundated by reservoir =	770	Source:	Satterthwaite, 1992;
Potential adults spawning in channel downstream of SRD =	154		based on 1974-81 carcass surveys
Total potential SRD spawning adults =	924		adjusted for prespawning mortality

SRD potential spawners are harvested at same rates as upper river run fish:

River harvest = 9.5%(run at mouth)

Ocean harvest = 2(run at mouth)

SRD potential spawners at mouth = SRD spawning adults + River harvest

Total adult increases if inundated spawning habitat were restored = SRD spawning adults + (river harvest + ocean harvest of SRD spawning adults)

Calculations:

SRD run at mouth = 924 + 0.095(SRD run at mouth)

(SRD run at mouth)(1-0.095) = 924

SRD run at mouth = 924/(0.905) = 1,021

River harvest = 0.095(1021) = 97

Ocean harvest = 2(1021) = 2,042

Total adult increases if inundated spawning habitat were restored = 924 + 97 + 2,042 = 3,063

$\boxed{\text{Total adult increases if inundated spawning habitat were restored = 3,063}}$

Table 2, continued. Estimated Fall Chinook Salmon Increases Resulting from Savage Rapids Dam Removal - Mid Range

Upstream adult passage at dam

Assumptions:

SRD adult upstream mortality = 15%(Adults at base of SRD) Source: Young, 1994 (estimated range 10-30% adult passage loss)

Spawning escapement = Gold Ray Dam counts + Spawning between SRD and GRD = 12,498

Spawning escapement = 0.85(Adults at base of SRD)

Calculations:

Adults at base of SRD = Spawning escapement/(0.85) = 12,498/(0.85) = 14,703

SRD adult upstream mortality = 0.15(14,703) = 2,205

Adult increase due to eliminating SRD adult passage loss = 2,205

Downstream juvenile passage at dam

Assumptions:

SRD juvenile mortality = 15%(juveniles migrating to SRD) Source: Young, 1994 (estimated average 10-15%, range 5-30%)

Wild juvenile-to-adult survival rate = 2% Source: ODFW unpublished data, 1976-90 average

(Juveniles produced each year)(Juvenile-to-adult survival) = Upper river adult run at mouth

Ignore loss to juveniles of potential spawning fish in SRD reservoir

Adult equivalent potential increase = (SRD juvenile mortality)(Juvenile-to-adult survival)

Calculations:

Juveniles produced = Upper river adult run at mouth/juvenile-to-adult survival = 17,728/0.02

Juveniles produced = 886,400

SRD juvenile mortality = 0.~~1~~5(886,400) = 132,960

Adult equivalent increase due to eliminating SRD downstream loss = (132,960)(0.02) = 2,659

Adult equivalent increase due to eliminating SRD downstream loss = 2,659

Total Fall Chinook Increase		Upstream Passage		Adult Equiv. Downstream Passage		Spawning Increase
7,927	=	2,205	+	2,659	+	3,063

Table 3. Estimated Summer Steelhead Increases Resulting from Savage Rapids Dam Removal - Mid Range

Upstream adult passage at dam

Assumptions:

SRD adult upstream mortality = 15%(Adults at base of SRD) — Source: Young, 1994 (estimated range 10-30% adult passage loss)

Gold Ray Dam counts = 6,016 — Source: Gold Ray Dam counts, 1942 - 93, average

Returns between Gold Ray and Savage Rapids dams = 3624 — Source: Satterthwaite, 1992

Upper river escapement = Gold Ray Dam Counts + Returns between Gold Ray and Savage Rapids

Upper river escapement = 0.85(Adults at base of SRD)

Calculations:

Upper river escapement = 6,016 + 3,624 = 9640

Adults at base of SRD = Upper river escapement/(0.85) = 9,640/(0.85) = 11,341

SRD adult upstream mortality = 0.15(11,341) = 1,701

Adult increase due to eliminating SRD adult passage loss = 1,701

Downstream juvenile passage at dam

Assumptions:

Most of river harvest is on half-pounders, produced above but harvested below SRD. — Source: ODFW, 1994, p.189

(Does not include adult returns from half-pounders to avoid double counting).

SRD juvenile mortality = 15%(juveniles migrating to SRD) — Source: Young, 1994 (estimated average 10-15%, range 5-30%)

Hatchery juvenile-to-half-pounder survival rate = 12% — Source: ODFW,1994, p.1, range = 3 - 28%, 1976-91 returns

Hatchery juveniles released = 144,523 — Source: ODFW,1994,p.134, 1974-91 average

(Current releases = 220,000) — Source: ODFW, hatchery release data, 1991-94

Juveniles migrating to SRD = 80%(Juveniles released each year) — Source: Evenson, personal communication, estimate

Half-pounder equivalent increase = (SRD juvenile mortality)(Juvenile-to-half-pounder survival)

Hatchery adults = 31% of total population passing Gold Ray Dam — Source: ODFW,1994, p.51, 1970-91 brood years

Hatchery adults = 0.31(6,016) = 1,865

Hatchery adults = (1,865)/(9,640) = 19.3% of total adults passing Savage Rapids Dam

Calculations:

Hatchery juveniles migrating to SRD = 0.80(144,523) = 115,618

SRD hatchery fish juvenile mortality = 0.15(115,168) = 17,343

Half-pounder equivalent increase of hatchery fish = (17,343)(0.12) = 2,081

Half-pounder equiv. increase wild + hatchery fish = half-pounder equiv. increase hatch. fish/percentage of hatchery adults of total passing SRD

Half-pounder equiv. increase wild + hatchery fish = (2081)/(0.193) = 10,782

Half-pounder equiv. increase wild fish = 10,782 - 2,081 = 8,701

Half-pounder equivalent increase due to eliminating SRD downstream loss = 8,701

Total Summer Steelhead Increase		Upstream Passage		Half-pounder Equiv. Downstream Passage
10,402	=	1,701	+	8,701

Table 4. Estimated Winter Steelhead Increases Resulting from Savage Rapids Dam Removal - Mid Range

Upstream adult passage at dam

Assumptions:

SRD adult upstream mortality = 15%(Adults at base of SRD) — Source: Young, 1994 (estimated range 10-30% adult passage loss)

Gold Ray Dam counts = 9,317 — Source: Gold Ray Dam counts, 1942 - 93, average

Returns between Gold Ray and Savage Rapids dams = 4056 — Source: Satterthwaite, 1992

Upper river escapement = Gold Ray Dam counts + Returns between Gold Ray and Savage Rapids

Upper river escapement = 9,317 + 4,056 = 13,373

Upper river escapement = 0.85(Adults at base of SRD)

Calculations:

Adults at base of SRD = Upper river escapement/(0.85) = 13,373/(0.85) = 15,733

SRD adult upstream mortality = 0.15(15,733) = 2,360

$\boxed{\text{Adult increase due to eliminating SRD adult passage loss = 2,360}}$

Downstream juvenile passage at dam

Assumptions:

Most of river harvest is on half-pounders, produced above but harvested below SRD. — Source: ODFW, 1994, p.189

(Does not include adult returns from half-pounders to avoid double counting).

SRD juvenile mortality = 15%(juveniles migrating to SRD) — Source: Young, 1994 (estimated average 10-15%, range 5-30%)

Hatchery juvenile-to-half-pounder survival rate = 12% — Source: ODFW, 1994

Hatchery juvenile-to-adult survival rate = 1.2% — Source: ODFW, hatchery data, (average, 1974-86 brood years)

Hatchery juveniles released = 121,000 — Source: ODFW,1990,p.68, 1976-86 average, Rogue stock only

(Current release target = 150,000) — Source: ODFW, hatchery release data, 1989-94

Juveniles migrating to SRD = 80%(Juveniles released each year) — Source: Evenson, personal communication, estimate

Adult equivalent increase = (SRD juvenile mortality)(Juvenile-to-adult survival)

Hatchery adults = 23% of total population passing Gold Ray Dam — Source: ODFW,1990, p.32, 1979-87 average

Hatchery adults = 0.23(9,317) = 2,143

Hatchery adults = (2,143)/(13,373) = 16% of total adults passing Savage Rapids Dam

Wild adults passing Savage Rapids Dam = Total upper river escapement - Hatchery adults = 13,373 - 2,143 = 11,230

Half-pounder return to river = 70% of total adult + half-pounder return — Source: ODFW, 1990,p.44, Angler catch, middle river, 1978/79 and 1979/80

Calculations:

Hatchery juveniles migrating to SRD = 0.80(121,000) = 96,800

SRD hatchery fish juvenile mortality = 0.15(96,800) = 14,520

Half-pounder equivalent increase of hatchery fish = 0.70 (14,520)(0.12) = 1,219

Half-pounder equiv. increase wild + hatchery fish = half-pounder equiv. increase hatch. fish/percentage of hatchery adults of total passing SRD

Half-pounder equiv. increase wild + hatchery fish = (1,219)/(0.16) = 7,619

Half-pounder equiv. increase wild fish = 7,619 - 1,219 = 6,400

Table 4, continued. Estimated Winter Steelhead Increases Resulting from Savage Rapids Dam Removal - Mid Range

Adult equivalent increase of hatchery fish = 0.30(14,520)(0.012) = 52
Adult equiv. increase of wild + hatchery fish = (52)/(0.16) = 325
Adult equiv. increase wild fish = 325 - 52 = 273
Total adult and half-pound equiv. increase of wild and hatchery fish = 7,619 + 325 = 7,944

		Adult and half-pounder equivalent increase due to eliminating downstream loss = 7,944		
Total Winter Steelhead Increase		Upstream Passage		Adult and Half-pounder Equiv. Downstream Passage
10,304	=	2,360	+	7,944

Table 5. Estimated Coho Salmon Increases Resulting from Savage Rapids Dam Removal - Mid Range

Upstream adult passage at dam

Assumptions:

SRD adult upstream mortality= 15%(Adults at base of SRD) — Source: Young, 1994 (estimated range 10-30% adult passage loss)
Gold Ray Dam counts = 1,981 — Source: Gold Ray Dam counts, 1942 - 93, average
Assume no wild fish spawning between Gold Ray and Savage Rapids dams
Upper river escapement = Gold Ray Dam counts = 0.85(Adults at base of SRD)

Calculations:

Adults at base of SRD = Upper river escapement/(0.85) = 1,981/(0.85) = 2,331
SRD adult upstream mortality = 0.15(2,331) = 350

Adult increase due to eliminating SRD adult passage loss = 350

Downstream juvenile passage at dam

Assumptions:

SRD juvenile mortality = 15%(juveniles migrating to SRD) — Source: Young, 1994 (estimated average 10-15%, range 5-30%)
Hatchery juvenile-to-adult survival rate = 2% — Source: Lewis, 1993 Average 1977-89 brood years,range 0.3-12%
Hatchery juveniles released = 200,000 — Source: ODFW, hatchery release data, 1985-94
(Juveniles produced each year)(Juvenile-to-adult survival) = Hatchery Adults produced (includes ocean harvest)
Juveniles migrating to SRD = 80%(Juveniles produced each year) — Source: Evenson, personal communication, estimate
Adult equivalent increase = (SRD juvenile mortality)(Juvenile-to-adult survival)

Calculations:

Juveniles migrating to SRD = 0.90(200,000) = 180,000
SRD juvenile mortality = 0.15(180,000) = 27,000
Adult equivalent increase = (27,000)(0.02) = 540

		Adult equivalent increase due to eliminating SRD downstream loss = 350		
Total Hatchery Coho Increase		Upstream Passage		Adult Equiv. Downstream Passage
890	=	350	+	540

Table 6. **Estimated Salmon and Steelhead Increases Resulting from Savage Rapids Dam Removal - Mid Range**

(Adults or adult equivalents contributing to ocean harvest, river harvest, and spawning)

Species	Upstream Passage	Downstream Passage	Spawning Habitat Increase	Total
Spring Chinook	5,493	8,604		14,097
Fall Chinook	2,205	2,659	3,063	7,927
Summer Steelhead	1,701	8,701		10,402
Winter Steelhead	2,360	7,944		10,304
Coho (hatchery fish only)	350	540		890
			Grand Total =	**43,620**

Table 7. Estimated Spring Chinook Salmon Increases Resulting from Savage Rapids Dam Removal - Low Range

Upstream adult passage at dam

GRD Counts	Loss SRD	Adults below SRD	SRD Upst. Increase
31,126	0.1	34,584	3,458

Downstream juvenile passage at dam

	# juvs	Loss SRD	Juv. loss	Surv to adult	Adult equiv increase
Hatchery	1,458,000	0.05	72,900	0.02	1,458
Wild	1,410,000	0.05	70,500	0.02	1,410
			Adult Equivalent Downstream Increase		2,868

Total Spring Chinook			Upstream Passage		Adult Equiv. Downstream Passage
Increase	6,326	=	3,458	+	2,868

Table 8. Estimated Fall Chinook Salmon Increases Resulting from Savage Rapids Dam Removal - Low Range

Above SRD Adult Production

GRD Count	SRD-GRD	Spawn Escapement	River harvest	Presp. mort	Ocean harv
3,148	9,350	12,498	0.095	0.2	2

Upper river run at mouth =	17,728		
River harvest =	1,684		
Prespawning mortality =	3,546		
Ocean harvest =	35,455	Above Savage Rapids Adult Production =	53,183

Adult spawning habitat increases

SRD run at mouth =	1,021	
River harvest =	97	
Ocean harvest =	2,042	
	3,063	= Total adult increases if spawning habitat were restored

Upstream adult passage at dam

Spawn Escapement	Loss SRD	Adults below SRD	SRD Upst. Increase
12,498	0.1	13,886	1,389

Downstream juvenile passage at dam

Surv.to adult	#juvs	Loss SRD	Juv loss	Adult equiv increase
0.02	886,383	0.05	44,319	886

Total Fall Chinook		Upstream Passage		Adult Equiv. Downstream Passage		Spawning Population Increase
Increase	5,338	1,389	+	886	+	3,063

Table 9. Estimated Summer Steelhead Increases Resulting from Savage Rapids Dam Removal - Low Range

Upstream adult passage at dam

GRD Count	SRD-GRD	Upper River Esc	Loss SRD	Ad.belowSRD	SRD Upst. Increase
6,016	3,624	9,640	0.1	10,711	1,071

Downstream juvenile passage at dam

Juv released	Surv to dam	Hatchery Juvs at SRD	Loss SRD	Hat. Juv. Increase
144,523	0.8	115,618	0.05	5,781

Half-pounder equiv. increase hatchery fish =	694	
Half-pounder equiv. increase wild + hatchery fish =	3,594	=SRD Half-pounder Equiv Downstream Increase
Half-pounder equiv. increase wild fish =	2,901	

Total Summer Steelhead			Upstream Passage		Half-pounder Equiv. Downstream Passage
Increase	4,665	=	1,071	+	3,594

Table 10. Estimated Winter Steelhead Increases Resulting from Savage Rapids Dam Removal - Low Range

Upstream adult passage at dam

GRD Count	SRD-GRD	Upper River Esc	Loss SRD	Ad.belowSRD	SRD Upst. Increase
9,317	4,056	13,373	0.1	14,858	1,486

Downstream juvenile passage at dam

Juv releasd	Surv to dam	Hatchery Juvs at SRD	Loss SRD	Hat. Juv. Increase
121,000	0.8	96,800	0.05	4,840

Half-pounder equiv. increase hatchery fish =	407	
Half-pounder equiv. increase wild + hatchery fish =	2,541	=SRD Half-pounder Equiv Downstream Increase
Half-pounder equiv. increase wild fish =	2,134	
Adult equivalent increase of hatchery fish =	17	
Adult equiv. increase of wild + hatchery fish =	109	
Adult equiv. increase wild fish =	91	
Total adult and half-pound equiv. increase of wild and hatchery fish =		2,650

Total Winter Steelhead			Upstream Passage		Adult and Half-pounder Equiv. Downstream Passage
Increase	4,136	=	1,486	+	2,650

Table 11. Estimated Coho Salmon Increases Resulting from Savage Rapids Dam Removal - Low Range

Upstream adult passage at dam

	GRD Count	Loss SRD	Adults below SRD	SRD Upst. Increase
	1981	0.1	2,201	220

Downstream juvenile passage at dam

	# juvs	#juv at SRD	Loss SRD	Juv. loss	Surv to adult	Adult equiv increase
Hatchery	200,000	180,000	0.05	9,000	0.02	180

Total Hatchery Coho Increase		Upstream Passage		Adult Equiv. Downstream Passage
400	=	220	+	180

Table 12. Estimated Salmon and Steelhead Increases Resulting from Savage Rapids Dam Removal - Low Range

(Adults or adult equivalents contributing to ocean harvest, river harvest, and spawning)

Species	Upstream Passage	Downstream Passage	Spawning Habitat Increase	Total
Spring Chinook	3,458	2,868		6,326
Fall Chinook	1,389	886	3,063	5,338
Summer Steelhead	1,071	3,594		4,665
Winter Steelhead	1,486	2,650		4,136
Coho (hatchery fish only)	220	180		400
			Grand Total =	20,866

Table 13. Estimated Spring Chinook Salmon Increases Resulting from Savage Rapids Dam Removal - High Range

Upstream adult passage at dam

GRD Counts	Loss SRD	Adults below SRD	SRD Upst. Increase
31,126	0.3	44,465	13,340

Downstream juvenile passage at dam

	# juvs	Loss SRD	Juv. loss	Surv to adult	Adult equiv increase
Hatchery	1,458,000	0.3	437,400	0.02	8,748
Wild	1,410,000	0.3	423,000	0.02	8,460
			Adult Equivalent Downstream Increase		17,208

Total Spring Chinook			Upstream Passage		Adult Equiv. Downstream Passage
Increase	30,548	=	13,340	+	17,208

Table 14. Estimated Fall Chinook Salmon Increases Resulting from Savage Rapids Dam Removal - High Range

Above SRD Adult Production

GRD Count	SRD-GRD	Spawn Escapement	River harvest	Presp. mort	Ocean harvest
3,148	9,350	12,498	0.095	0.2	2

Upper river run at mouth =	17,728		
River harvest =	1,684		
Prespawning mortality =	3,546		
Ocean harvest =	35,455	Above Savage Rapids Adult Production =	53,183

Adult spawning habitat increases

SRD run at mouth =	1,021	
River harvest =	97	
Ocean harvest =	2,042	
	3,063	= Total adult increases if spawning habitat were restored

Upstream adult passage at dam

Spawn Escapement	Loss SRD	Adults below SRD	SRD Upst. Increase
12,498	0.3	17,854	5,356

Downstream juvenile passage at dam

Surv.to adult	#juvs	Loss SRD	Juv loss	Adult equiv increase
0.02	886,383	0.3	265,915	5,318

Total Fall Chinook		Upstream Passage		Adult Equiv. Downstream Passage		Spawning Population Increase
Increase	13,737	5,356	+	5,318	+	3,063

Table 15. Estimated Summer Steelhead Increases Resulting from Savage Rapids Dam Removal - High Range

Upstream adult passage at dam

GRD Count	SRD-GRD	Upper River Esc	Loss SRD	Ad.belowSRD	SRD Upst. Increase
6,016	3,624	9,640	0.3	13,771	4,131

Downstream juvenile passage at dam

Juv released	Surv to dam	Hatchery Juvs at SRD	Loss SRD	Hat. Juv. Loss
144,523	0.8	115,618	0.3	34,686

Half-pounder equiv.increase hatchery fish = 4,162
Half-pounder equiv. increase wild + hatchery fish = 21,566 = SRD Half-pounder Equiv Downstream Increase
Half-pounder equiv. increase wild fish = 17,404

Total Summer Steelhead			Upstream Passage		Half-pounder Equiv. Downstream Passage
Increase	25,697	=	4,131	+	21,566

Table 16. Estimated Winter Steelhead Increases Resulting from Savage Rapids Dam Removal - High Range

Upstream adult passage at dam

GRD Count	SRD-GRD	Upper River Esc	Loss SRD	Ad.belowSRD	SRD Upst. Increase
9,317	4,056	13,373	0.3	19,104	5,731

Downstream juvenile passage at dam

Juv released	Surv to dam	Hatchery Juvs at SRD	Loss SRD	Hat. Juv. Loss
121,000	0.8	96,800	0.3	29,040

Half-pounder equiv. increase hatchery fish = 2,439
Half-pounder equiv. increase wild + hatchery fish = 15,246 = SRD Half-pounder Equiv Downstream Increase
Half-pounder equiv. increase wild fish = 12,807

Adult equivalent increase of hatchery fish = 105
Adult equiv. increase of wild + hatchery fish = 653
Adult equiv. increase wild fish = 549
Total adult and half-pound equiv. increase of wild and hatchery fish = 15,899

Total Winter Steelhead			Upstream Passage		Adult and Half-pounder Equiv. Downstream Passage
Increase	21,631	=	5,731	+	15,899

Table 17. Estimated Coho Salmon Increases Resulting from Savage Rapids Dam Removal - High Range

Upstream adult passage at dam

	GRD Count	Loss SRD	Adults below SRD	SRD Upst. Increase
	1981	0.3	2,830	849

Downstream juvenile passage at dam

	# juvs	#juv at SRD	Loss SRD	Juv. loss	Surv to adult	Adult equiv increase
Hatchery	200,000	180,000	0.3	54,000	0.02	1,080

Total Hatchery Coho			Upstream Passage		Adult Equiv. Downstream Passage
Increase	1,929	=	849	+	1,080

Table 18. Estimated Salmon and Steelhead Increases Resulting from Savage Rapids Dam Removal - High Range

(Adults or adult equivalents contributing to ocean harvest, river harvest, and spawning)

Species	Upstream Passage	Downstream Passage	Spawning Habitat Increase	Total
Spring Chinook	13,340	17,208		30,548
Fall Chinook	5,356	5,318	3,063	13,737
Summer Steelhead	4,131	21,566		25,697
Winter Steelhead	5,731	15,899		21,631
Coho (hatchery fish only)	849	1,080		1,929
			Grand Total =	93,542

Table 19. Summary of Estimated Salmon and Steelhead Increases Resulting from Savage Rapids Dam Removal for Low, Mid, and High Range Values

(Adults or adult equivalents contributing to ocean harvest, river harvest, and spawning)

Species	Low Range	Mid Range	High Range
Spring Chinook	6,326	14,097	30,548
Fall Chinook	5,338	7,927	13,737
Summer Steelhead	4,665	10,402	25,697
Winter Steelhead	4,136	10,304	21,631
Coho (hatchery fish only)	400	890	1,929
Totals:	20,865	43,620	93,542

Figure 1. Potential Increased Salmon and Steelhead Returns for Harvest and Spawning resulting from Savage Rapids Dam Removal

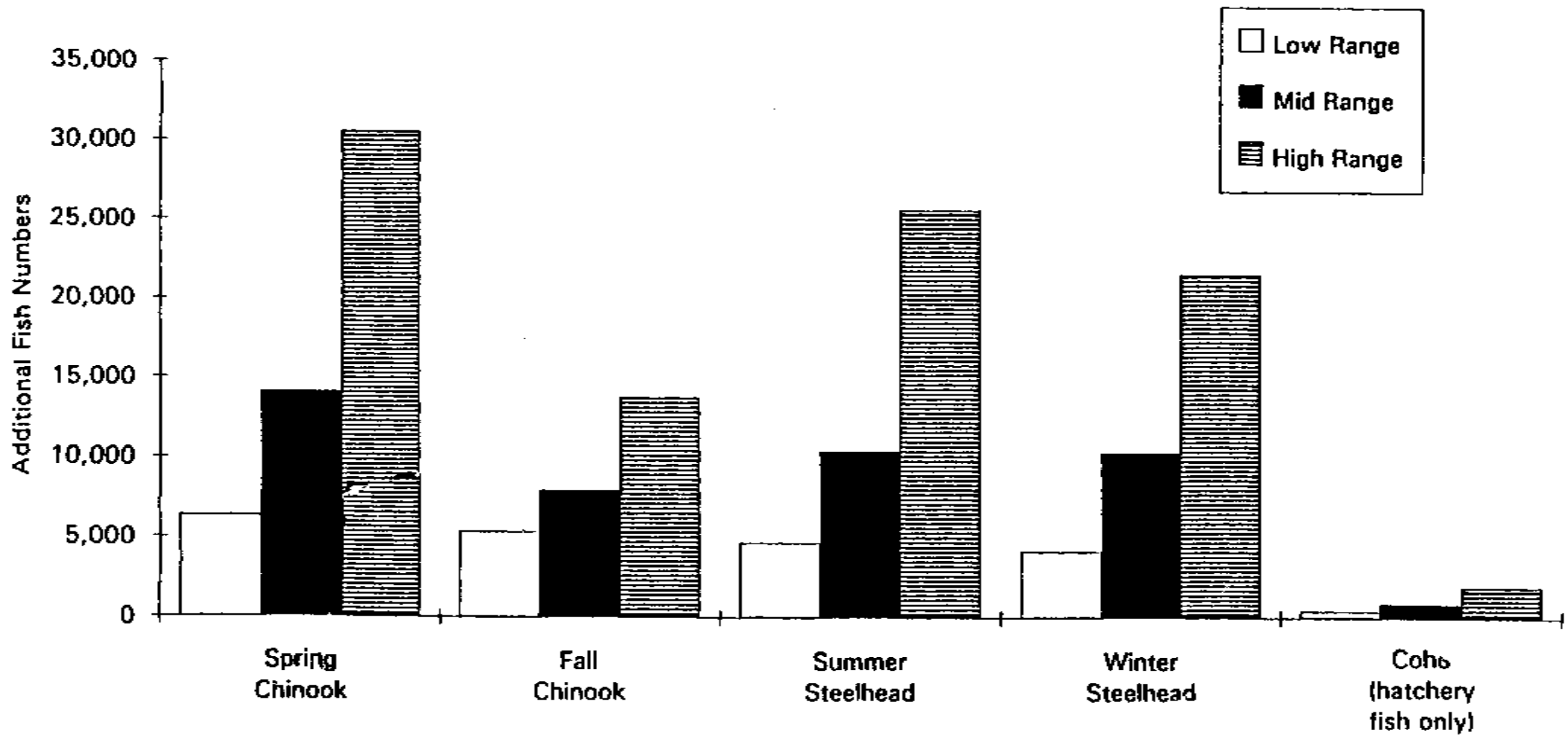
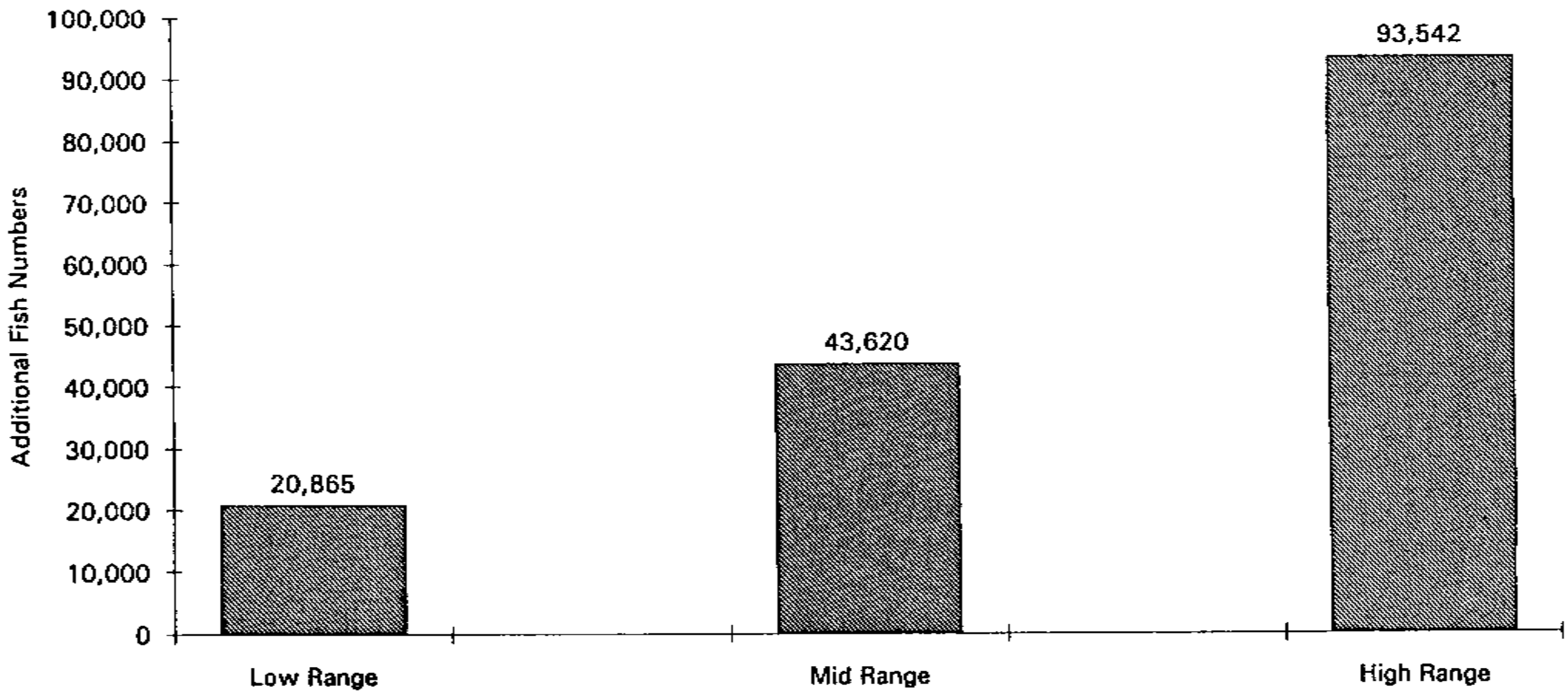


Figure 2. Total Potential Increased Salmon and Steelhead Returns for Harvest and Spawning resulting from Savage Rapids Dam Removal



Appendix E. Salvage Reporting Form

SALVAGE REPORTING FORM

INSTRUCTIONS

The applicant must submit a complete Salvage Reporting Form, or its equivalent, with the following information to National Marine Fisheries Service at: ken.phippen@noaa.gov within 10 days of completing a capture and release.

1. Date

2. Corp Action ID

3. Applicant

4. Location of fish salvage operation (County and 5th field HUC)

5. Project Name

6. Corps contact

7. Date of fish salvage operation

8. Supervisory Fish Biologist
   - Name
   - Address
   - Telephone number

9. Describe methods used to isolate the work area, remove fish, minimize adverse effects on fish and evaluate their effectiveness

10. Describe the stream conditions before and following placement and removal of barriers

11. Describe the number of fish handled, condition at release, number, injured, number killed by species

Appendix F. Letters of concurrence from NOAA-Fisheries and Oregon Department of Fish and Wildlife

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
PORTLAND OFFICE
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

July 13, 2005

RECEIVED
JUL 15 2005
USFWS
Roseburg Field Office

Mr. Craig Tuss
Field Supervisor
U.S. Fish and Wildlife Service
2900 NW Stewart Parkway
Roseburg, Oregon 97470

Re: Comments on the Draft Supplemental Fish and Wildlife Coordination Act Report for the Proposed Savage Rapids Dam Removal Project, Josephine County, Oregon

Dear Mr. Tuss:

This correspondence is in response to your June 16, 2005, request for comments on the Draft Supplemental Fish and Wildlife Coordination Act Report (CAR) for the proposed Savage Rapids Dam (SRD) Removal Project, in Josephine County, Oregon. The National Marine Fisheries Service (NMFS) reviewed the CAR and is providing this correspondence for support and clarification.

Jointly, the U.S. Fish and Wildlife Service (USFWS), NMFS, and the Oregon Department of Fish and Wildlife are working together to provide advice and recommendations to the Bureau of Reclamation (BOR) concerning the SRD project. Close coordination throughout the process of developing the original CAR in 1995, and this 2005 supplement, has resulted in the need to provide only a few comments on the draft CAR. Minor typographical or grammatical suggestions will be provided directly to you.

The NMFS would like to clarify a statement regarding the fisheries benefits of the Elk Creek Dam contained in the original 1995 CAR and repeated in this document. On page 28, the third paragraph states

> "Although Lost Creek, Applegate, and Elk Creek (if it is completed) Dams are primarily for flood control, another major purpose of the Rogue River Basin Project is to enhance anadromous fish runs."

The NMFS completed an analysis and Section 7 Endangered Species Act (ESA) consultation on the Elk Creek Dam fish passage alternatives (refer to NMFS No.: 2001/00018) and concluded only the dam breaching alternative would avoid jeopardizing the continued existence of Southern Oregon/Northern California (SONC) coho salmon (*Oncorhynchus kisutch*). Therefore, NMFS can not support the statement that implies Elk Creek Dam will enhance anadromous fish runs.

In addition to the impacts of the Elk Creek Dam, the other two dams listed have some benefits to anadromous runs, but also some species-specific impacts. We recommend the sentence be revised to say:

> "Although Lost Creek and Applegate Dams are primarily for flood control, another intended purpose of the Rogue River Basin Project is to enhance anadromous fish runs."

We believe the overall impacts of these other two dams on anadromous fisheries are yet to be fully recognized.

The NMFS fully supports the recommendations contained within the CAR. While the recommendations in the CAR are relatively specific and detailed, NMFS is aware the BOR continues to refine the proposed action. The BOR is required to consult with NMFS concerning any Federal action they authorize, fund, or carry out that may affect species listed under the ESA. Therefore, NMFS will provide BOR additional guidance during that process to minimize or avoid impacts to SONC coho salmon.

Please direct questions regarding this letter to Ken Phippen, Branch Chief of the Southwest Oregon Habitat Branch of the Oregon State Habitat Office at 541.957.3385.

Sincerely,

Michael P. Tehan
Director, Oregon State Habitat Office
Habitat Conservation Division

cc: Dan VanDyke, ODFW

Oregon

Theodore R. Kulongoski, Governor

Department of Fish and Wildlife
Rogue Watershed District Office
1495 East Gregory Road
Central Point, OR 97502
(541) 826-8774
FAX: (541) 826-8776

July 20, 2005

Mr. Craig Tuss
Field Supervisor
US Fish and Wildlife Service
2900 NW Stewart Parkway
Roseburg, OR 97470

RE: Comments on the Draft Supplemental Fish and Wildlife Coordination Act Report for the proposed Savage Rapids Dam removal project.

Dear Mr. Tuss:

This letter responds to your June 16, 2005 request for comments on the Draft Supplemental Fish and Wildlife Coordination Act Report (CAR) for the proposed Savage Rapids Dam removal project. As you state in the report preface, the preferred alternative to remove Savage Rapids Dam and replace the dam with a pumping facility to provide water for the Grants Pass Irrigation District has already been chosen. This supplemental report primarily refines recommendations on inwater work and measures to minimize impacts to fish and wildlife resources during project implementation by the Bureau of Reclamation.

The Oregon Department of Fish and Wildlife (ODFW) supports the recommended changes to the project and project schedule contained within the CAR (pages 54-57) with the following comments. I will provide additional minor recommendations directly to you, including updated hatchery release numbers.

- State law requires ODFW approval of the details for the dam removal component of the project. The key items for this approval will be ensuring that the portions of the dam remaining after project completion (apron and bays) do not constrict the active channel (two year flood width) or create a low flow passage barrier, and that unexpected passage problems immediately following dam removal will be corrected. This approval and these details may be addressed through the remaining permitting processes or directly with ODFW.

- One of the key recommendations from the natural resource agencies is that the period of reservoir drawdown at Savage Rapids be held to the minimum needed to complete the work, in order the minimize the impacts on migrating fish. This recommendation is clearly stated in the CAR.

- As you have combined recent information and developments into the text of the original 1995 CAR, some incongruence in language and data remain that could be confusing to the reader. The returns of most anadromous salmonids in the Rogue have been higher in recent years than in the years leading up to the original CAR. This comment is provided as a note of clarification.

- The CAR refers to the ratio of adult hatchery fish and naturally produced wild fish in various counting locations in the watershed. It is important to note that these numbers show the passage of hatchery adults to a terminal facility in the upper watershed, and do not equate to stray rates observed on the spawning grounds. This comment is provided as a note of clarification.

- Please note that fish management within the Oregon Department of Fish and Wildlife is guided by the Native Fish Conservation Policy, which can be found at the following address: www.dfw.state.or.us/fish/nfcp/nfcp.pdf. The Native Fish Conservation Policy has replaced the Wild Fish Policy referred to in the draft CAR

If you have any questions, please contact me at 541.826.8774.

Sincerely,

Dan Van Dyke
District Fish Biologist

Cc: Ken Phippen, NMFS